1. INTRODUCTION

GlowCore is founded on two basic principles: to engineer and manufacture high-efficiency heating and cooling equipment to the highest quality standards, and to provide marketing and service assistance to professional heating contractors which will in turn add value to our products for the sake of the consumer.

This manual is designed as a part of our ongoing commitment to aid our dealers and their personnel in getting the most out of our products, and to provide guidance in applications and service so that GlowCore installations will be as trouble-free and versatile as possible.

The intent of the manual is to share a growing body of knowledge about our products and their applications. Acknowledgment is made to various companies and individuals who have generously shared their expertise and insight into the HVAC industry, among them our suppliers and trade organizations, our staff in the field, and particularly our loyal dealers and distributors.

No representation is made that this manual is the complete and final word on GlowCore or on heating and cooling in general; much to the contrary, the very nature of GlowCore equipment lends itself to diverse uses and limitless variations.

Each installation is the responsibility of the installer as to proper application, performance, adaptation to unusual conditions or environments, and conformation to local, state, and national codes as installed.

2. GB SERIES BOILER

The GlowCore boiler is unique in its concept and design when compared with all other boilers on the market today. While the applications for which the boiler was designed are the same as those for which other boilers are used, the GB boiler has certain features that not only make it more efficient but also present some design considerations that must be addressed to achieve the efficiency and reliability that have been designed into the boiler. FIG 2. shows the basic components and configuration of the UniCore integrated heating and hot water boiler.

The following text attempts to create a clear and logical path to follow in designing a new heating system or evaluating the existing system as to the applicability of the distribution system, the selection of the proper equipment, the location of the new boiler and components, and the application--either retrofit or new construction--in residential, single boiler applications, and multiple boiler applications.

2.1. CERTIFICATION

GlowCore heating products are designed and tested according to standards established by the American National Standards Institute, and are tested and listed by the American Gas Association and the Canadian Gas Association as complying with those standards.

GB boilers are constructed to A.S.M.E. standard IV for low pressure boilers. The national board number and the A.S.M.E. stamp appear on a plate welded to the primary heat exchanger. To gain access to the rating plate the sheet metal panel and insulation covering the heat exchanger must be removed. The GB boiler may be operated at working pressures up to 100 psi.

2.2. RESIDENTIAL/COMMERCIAL APPLICATIONS

For the sake of this series of application manuals all single boiler applications involving heat and domestic hot water are considered residential applications. All residential applications are defined here as single boiler systems. Multiple boiler applications are considered commercial applications though multiple boilers may have applications in larger residential settings.

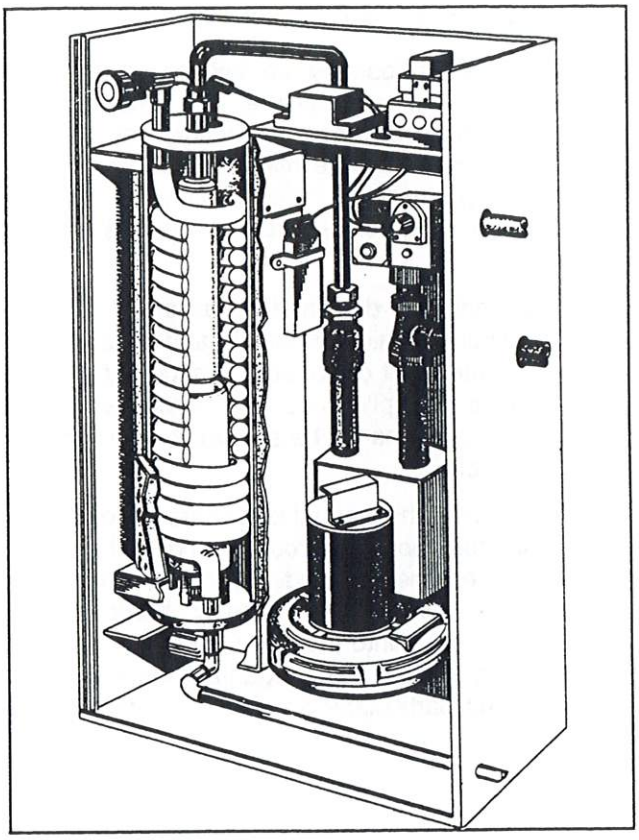


FIG 2. *GB boiler cutaway view.*

2.3. NEW SYSTEM VS. RETROFIT SYSTEM

In this manual a new system is regarded as being any system that utilizes all new components properly selected and sized for the application in question. Retrofit systems are those that make use of existing components, particularly radiators, convectors, or baseboard, which present parameters within which the boiler system must be designed for proper operation.

2.4. LOW WATER VOLUME BOILERS

Because of their high water content and mass of metal, cast iron and steel boilers are less responsive but somewhat more forgiving of design errors. Short-cycling of the burner on the temperature limit control is less pronounced, though no less detrimental to operation, because the boiler itself will absorb and radiate a significant amount of heat. Low water volume boilers respond more quickly to a call for heat, can be made more compact and lightweight, but must have adequate heat delivery systems to avoid short-cycling of the burner on the temperature limit control.

The heat delivery system's output must be equal to or greater than the boiler's output to fully load the boiler or short-cycling will occur.

Likewise, pumping rates of water through low water volume boilers must be maintained so that water is moved through the boiler fast enough so as not to reach boiling temperatures. The slower the water moves through the boiler the more heat it will absorb and the higher temperatures will rise. Consequently, the pump selected must be adequate to maintain that critical flow of water. Proper pumping in most types of boilers will yield a 20°F differential between supply and return temperatures.

3. SINGLE BOILER SYSTEM DESIGN

The following step-by-step method is recommended to provide useful information in determining the feasibility of the various options that exist when designing a hydronic heating system. See SEC. 4. for a discussion of multiple boiler applications.

3.1. STEP 1: TALK WITH THE HOMEOWNER

Before deciding which type of distribution system to use in the installation, evaluate the needs and objectives of the homeowner by asking about intended uses and discussing the various special applications possible with hydronic systems including domestic water heating, pool or spa heating. Such applications will need to be considered in the overall layout and zoning of the system.

Many types of heat distribution equipment are available--radiators, finned-tube baseboard, convectors, radiant panels, and air handlers to name a few--and each type can be adapted to the GlowCore GB boiler. Very often the selection of equipment is based on aesthetic considerations as well as performance. Talk with the homeowner to determine the priorities and objectives for the system. Decide which type of system best fits the homeowner's needs.

In retrofit applications the distribution system is most often the given factor to which the boiler, control, and pumping components must be adapted.

3.2. STEP 2: CALCULATE HEAT LOSS

Perform a room by room heat loss calculation according to the Hydronics Institute (I=B=R) or ACCA (Air Conditioning Contractors of America) standards to determine how much radiation is needed in each room and the building's total heat loss to determine which size GB boiler is needed. Several other acceptable methods of calculating heat loss are available which will give satisfactory results pertaining to equipment sizing, but any accepted method should give the same results.

3.3. STEP 3: SIZE RADIATION

A radiator or convector's ability to deliver heat is a function of water temperature and rate of delivery to the unit. Most systems in the past have been rated at about 180°F. It is advisable, though not imperative, to use ratings published at 150°F. with the GlowCore high efficiency system. Lower water temperatures in the system tend to increase the efficiency of the boiler and will help assure that the boiler is subjected to a sufficient load to avoid short-cycling.

GlowCore boilers are capable of temperatures of at least 180°F but the higher the temperature of the return water, the lower the efficiency of the system. This is true of all boilers, though all noncondensing boilers must be kept at higher temperatures (above 140°F) to avoid condensation in the boiler that destroys such boilers quickly. Materials used in the GB boiler are made to withstand the condensate's corrosive nature.

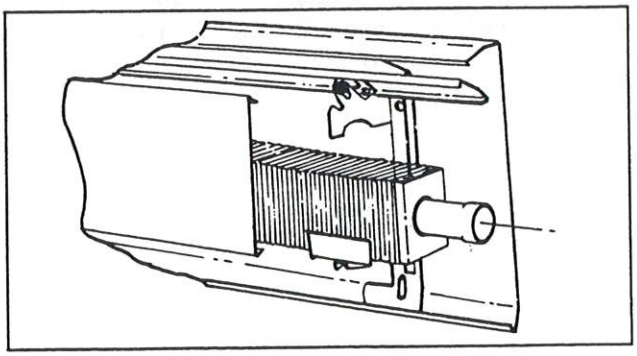


FIG. 3.3.1. *Finned-tube baseboard radiation.*

3.3.1. FINNED-TUBE BASEBOARD RADIATION

Most common in new hydronic systems is copper finned-tube baseboard radiation (FIG. 3.3.1). Baseboard radiation can be designed to give even comfort throughout the living space by blanketing the exterior walls with a gentle flow of warm air. Baseboard is custom fitted by the installer and can be made to fit almost anywhere heat is needed.

The baseboard is a visible part of the heating system and may or may not be aesthetically objectionable to the homeowner. Baseboard radiation may place some restrictions on the placement of furniture in the home.

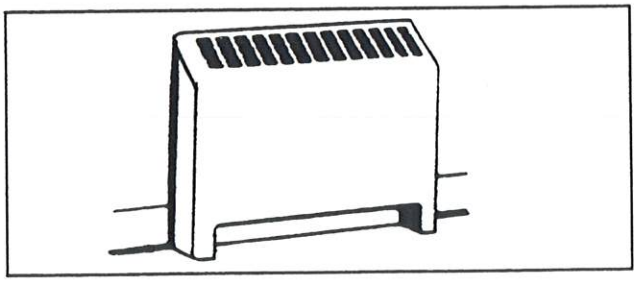


FIG. 3.3.2. *Freestanding convector.*

3.3.2. CONVECTORS

Convectors (FIG. 3.3.2) are available in many shapes and sizes and decorative panels may make these types of units more aesthetically pleasing, but convectors may influence furniture placement. Convectors are usually finned coils contained in a cabinet and are located within the area to be heated.

3.3.3. RADIATORS

Cast iron radiators (FIG. 3.3.3) have been used for years and are now virtually unavailable as new equipment. Cast iron baseboard, which can be used much like copper finned-tube radiation, is still manufactured but tends to be quite expensive. Cast iron radiators or baseboard work very well at lower temperatures and give very good heat delivery when installed properly.

3.3.4. HYDRONIC RADIANT FLOORS

Hydronic radiant floors (FIG. 3.3.4), while not a new application, have been gaining acceptance in recent years with the advent of plastic tubing which can be buried in concrete slabs or applied over subflooring in a lightweight concrete mix. Usually the tubing is 1/2 or 3/4 inch flexible tubing of synthetic rubber, polybutylene or cross-linked polyethylene (PePex) through which water is pumped at relatively low temperatures, usually not above 120°F.

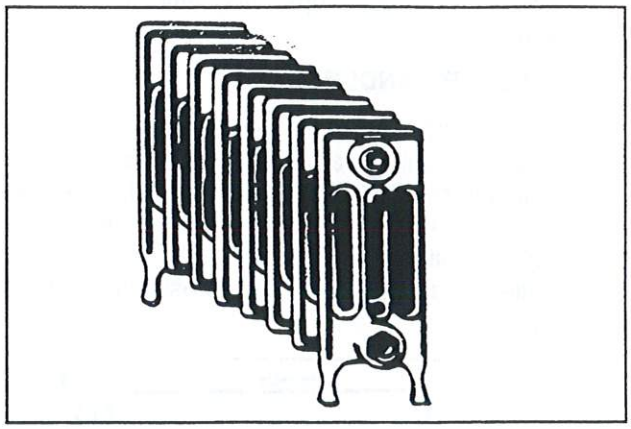


FIG. 3.3.3. *Cast iron radiator.*

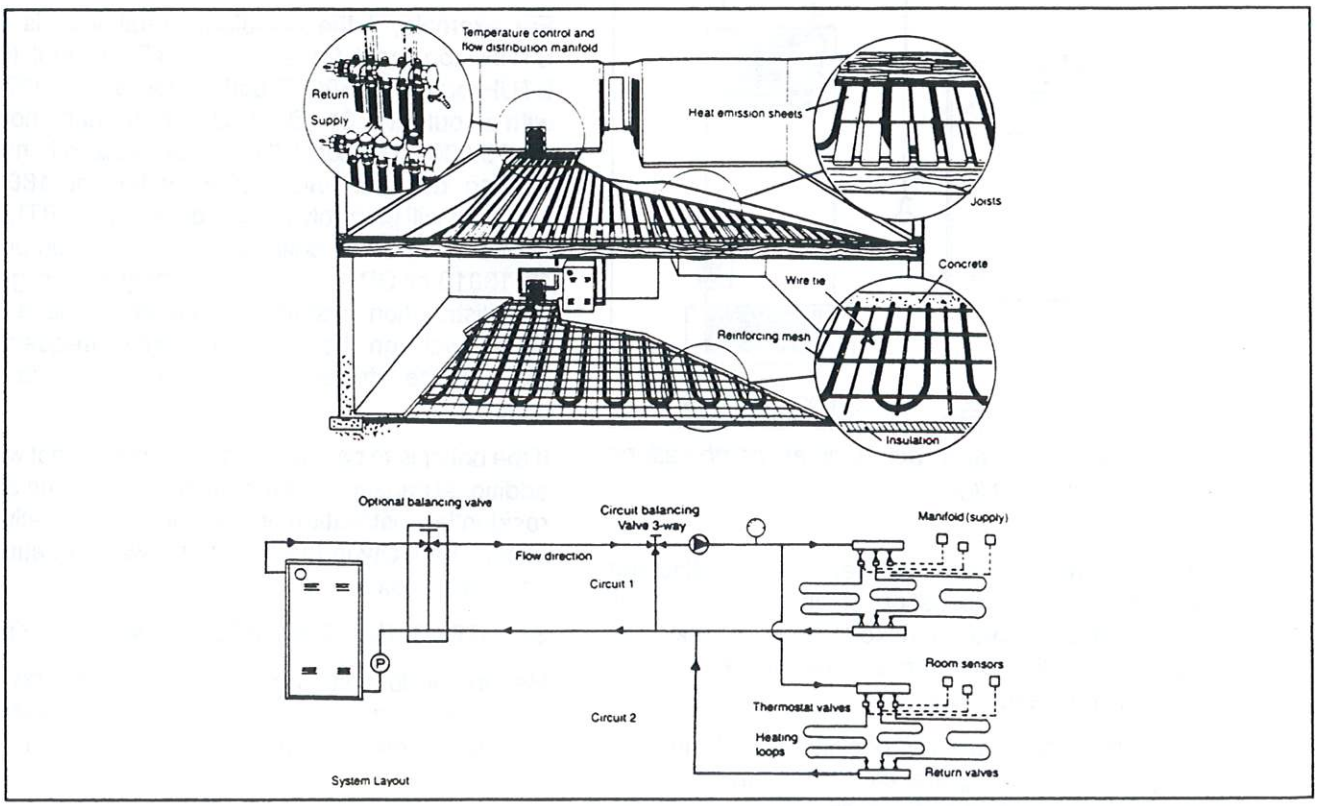


FIG. 3.3.4. *Hydronic radiant floors can be used with concrete slab or wood joist construction.*

This type of heat distribution creates an exceptionally evenly heated environment and since it is hidden beneath the finished flooring does not interfere with furniture placement. The homeowner has complete freedom to decorate without having to contend with any heating equipment visible in the home's interior. The low operating temperatures of this type of system lead to very good operating efficiencies in the GB series boiler.

3.3.5. AIR HANDLERS

For applications which require both forced air and hydronic heating capabilities, air handlers (FIG. 3.3.5) which derive their heat from heated boiler water are available in various sizes and air flow capacities. These units consist of a finned coil through which boiler water is pumped and across which air is moved by a blower.

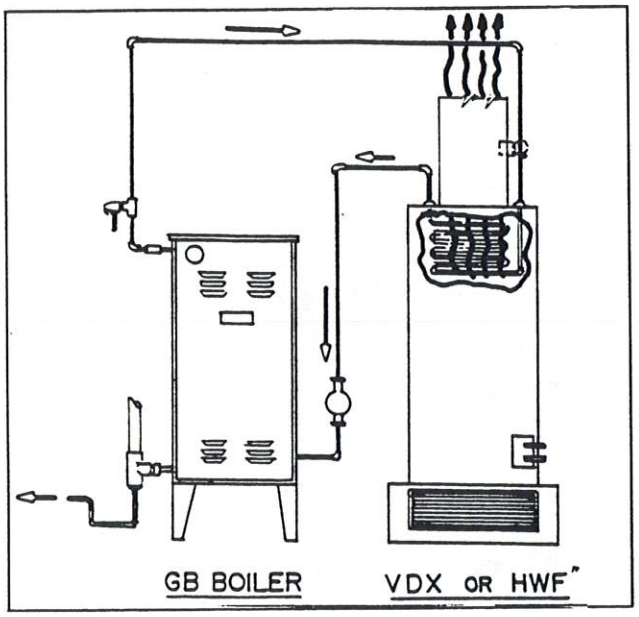


FIG. 3.3.5. *Boiler and air handler combinations provide design flexibility.*

These air handlers may also serve air conditioning functions with the application of an evaporator coil and lend themselves to mixed use--hydronic and forced air--applications since they are essentially water to air heat exchangers.

Air handlers increase the possibilities of multiple zoning for both heating and air conditioning and may be employed to solve difficult application problems such as split foyer houses where a single duct system is difficult to install. The air handler can be located remotely from the boiler allowing for a centralized boiler room.

Only relatively small diameter water piping needs to be installed between the remote air handler and the boiler.

See SEC. 20. for ratings and specifications of GlowCore UniCore Jr. air handlers, models HWF and VDX.

3.4. STEP 4: SIZE BOILER

The size of the boiler to be used is determined by the total calculated heat loss of the building. Match the calculated heat loss with the boiler's rated output. Boiler output should be no greater than the total capacity of the distribution system. Choose the smallest size boiler possible which will still have a large enough output to meet the heating load.

Sizing radiation for 150 or 160°F boiler water leads to better efficiency in the boiler while allowing a little excess distribution capacity for an extreme weather peak or for pick-up loads as when coming out of a temperature setback condition. At 180°F, the radiation will have a greater output capacity than at 160°F and should fully load the boiler. Use only the next size larger boiler.

For example, if the calculated heat loss is 75,000 BTUH, too great for a 60,000 BTUH input (54,000 BTUH output) GB0607 boiler, use a GB0907 boiler with an output of 81,000 BTUH, more than enough for the 75,000 BTUH load. If radiation is sized to meet the heating demand with 160°F water, at 180°F the radiation will probably put out over 90,000 BTUH, well above a GB0907 boiler's output. The output of a GB13010 or GB16014 would simply be too great for this distribution system and either of these boilers would cycle on their operating limits frequently and not produce efficiencies up to the potential of the boiler.

If the boiler is to be used to heat domestic hot water no additional capacity is normally needed for the average residential installation since there is usually some excess capacity in the boiler and water heating is an intermittent load.

3.5. STEP 5: DESIGN WATER HEATING OPTIONS

Heating of domestic hot water (FIG. 3.5) and special applications such as pool or hot tub heating are excellent applications for the GlowCore boiler.

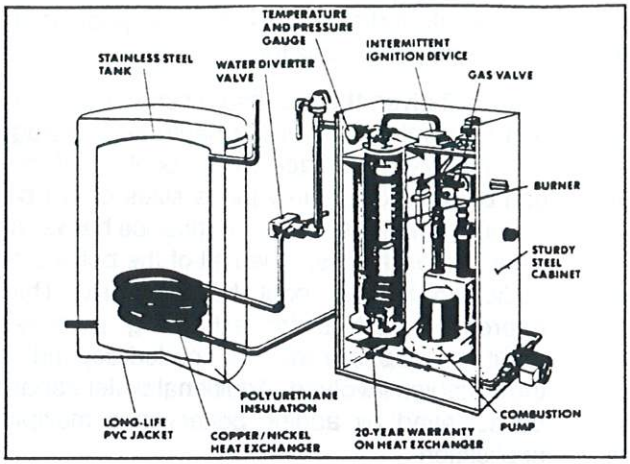


FIG. 3.5. *WT series water heater gives high efficiency and high recovery rates.*

Recovery rates and efficiencies are superior to virtually all other alternative types of equipment available for such purposes.

Select the proper size water tank or water-to-water heat exchanger based on the loads to be met. GlowCore WT series water heater specification sheets (see SEC. 24.) include instructions on determining the proper size tank to use. Information on Spirec heat exchangers (FIG. 3.5.1) is available from Spirec N.A., 141 Lanza Ave., Garfield, NJ, 07026. (201)478-1701

3.5.1. HOT TUB REHEATING/POOL HEATING

With the addition of a water-to-water heat exchanger as a separate zone, hot tub or pool heating can be accomplished with the same high efficiency as space heating. In applications where water from a pool or hot tub is reheated no storage tank is required. GB boilers are not approved in applications where pool or spa water is pumped directly through the boiler. By making the pool heating function the last priority of the heating system, excess capacity of the boiler can be put to good use. Additional capacity for pool or hot tub heating function may be required.

Maximum design loads for heating are only present on a few days out of each heating season. At other times outdoor temperatures will be above design conditions and the boiler will not need to run constantly for heating.

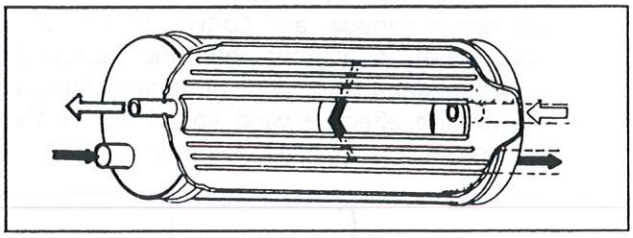


FIG. 3.5.1. *Stainless steel Spirec heat exchangers are available in various capacities.*

Hot tub heating from late spring to early fall works best since space heating loads are usually low. Pools and hot tubs to be heated during the winter months need to be considered separately to assure adequate heat.

TABLE 1 shows the temperature rise which can be achieved by the various sizes of boilers in hot tubs of different capacities (in gallons) in one hour with the boiler's output dedicated to hot tub heating.

3.5.2. OUTDOOR POOL HEATING LOAD

An outdoor pool's heating requirements are determined by several factors: desired temperature rise (the difference in temperature between the desired pool temperature and air temperature during the coldest month the pool will be in use), surface area of the pool, conduction through the walls and bottom of the pool, and wind speeds across the surface of the pool.

BOILER MODEL	BTU OUTPUT	CAPACITY OF HOT TUB, GALLONS					
		300	400	500	600	700	800
GB0607	53,460	21	16	13	11	9	8
GB0907	79,920	32	24	19	16	14	12
GB13012	115,440	46	35	28	23	20	17
GB16014	142,080	57	43	34	29	24	21

TABLE 1. *Temperature rise produced in one hour by GB series boilers in various sizes of hot tubs.*

Since soil is a poor conductor of heat, losses through pool walls and bottom may be ignored in below ground pools. Above ground pool walls will lose an amount of heat significant enough to require consideration.

Convection, radiation, and evaporation all occur simultaneously across the water's surface. The evaporation process gains most of the heat required in the phase change from liquid to vapor from the pool water. Heat energy is radiated to the atmosphere by the pool's surface, and convection occurs anytime pool water is warmer than the surrounding air. Fencing around the pool or nearby buildings may reduce the effective wind speed across the pool's surface so wind loads may not be as high as weather data would indicate. Covering the pool when not in use will help to reduce these loads.

TABLE 2 gives the maximum surface area in square feet (assuming 5‹'average depth and average 3 1/2 mile per hour wind across the pool's surface) which can be heated by the various sizes of GB boilers at various temperature rises (difference between air and water temperatures) when all of the boiler's output is dedicated to the pool heating task. This quick reference chart is for estimating purposes only. Additional capacity may be needed depending on all the variables involved. Additional boiler capacity may be achieved by adding boilers in a multiple boiler application.

BOILER MODEL	BTU OUTPUT	TEMPERATURE RISE				
		15°	20°	25°	30°	35°
GB0607	53,460	352	262	208	176	150
GB0907	79,920	529	392	312	264	224
GB13012	115,440	764	567	451	382	324
GB16014	142,080	940	698	555	470	399

TABLE 2. *Number of square feet of in ground pool surface which can be heated to various temperature rise levels (difference between water and air temperature) by GB series boilers assuming 3 1/2 mile per hour wind speed across pool surface.*

3.5.3. HIGH DEMAND WATER HEATING

If higher than normal water heating demands are anticipated, as in water heating for commercial purposes or in residences with large bathtubs or whirlpools which are filled with fresh hot water for each use, special consideration may need to be given to those loads. TABLE 3 indicates the performance which can be expected with various boiler and water tank combinations.

To increase the available hot water, either storage capacities or input can be increased. A larger tank, or two or more tanks in tandem, will increase the amount of hot water available on demand. Recovery rates will only increase as a function of boiler input. Usually high demands are only required at peak use time, for example when the whirlpool tub is filled.

Having a larger amount of hot water stored and ready for use will satisfy peak demands without the need for additional boiler input.

If larger storage capacity is installed, run times for the boiler will be increased in the water heating mode.

Since water heating takes precedence over space heating in the typical installation with a three-way diverter valve, temperatures in the heated space may fall to an unacceptable level during water heating. To compensate for this type of high demand water heating configuration, a control system which will switch boiler function back to space heating may be required.

A two-stage room thermostat with the second stage heating contacts energizing a normally-closed relay wired in the tank aquastat circuit will stop the water heating function should the room fall below a user-adjustable secondary setpoint, usually about 2°F below the normal room setpoint. Using a larger boiler for water heating may be necessary in some installations but is generally not the recommended procedure because the boiler would then tend to be oversized for the space heating function and sufficient load may not be available to the boiler in the space heating mode

for best performance and efficiency.

A timer relay which will periodically release the boiler from water heating mode and revert to heating function if required before continuing the water heating task may also serve the same purpose. See FIG. 3.5.3 for information on a suggested timer relay configuration.

Step firing two or more boilers with a suitable control will give increased flexibility in boiler operation and will probably result in better system efficiencies.

Tank Model No.	60,000 BTUH		90,000 BTUH		130,000 BTUH		160,000 BTUH	
	140°F (90°RISE)	115°F (65°RISE)	140°F (90°RISE)	115°F (65°RISE)	140°F (90°RISE)	115°F (65°RISE)	140°F (90°RISE)	115°F (65°RISE)
WT30SS	85gals.	112gals.	130gals.	173gals.				
WT40SS	100gals.	132gals.	141gals.	188gals.	148gals.	197gals.		
WT60SS	120gals.	159gals.	160gals.	212gals.	166gals.	221gals.		
WT40SSC							165gals.	219gals.
WT60SSC							185gals.	246gals.

TABLE 3. *Boiler/WT series water heater capacities.*

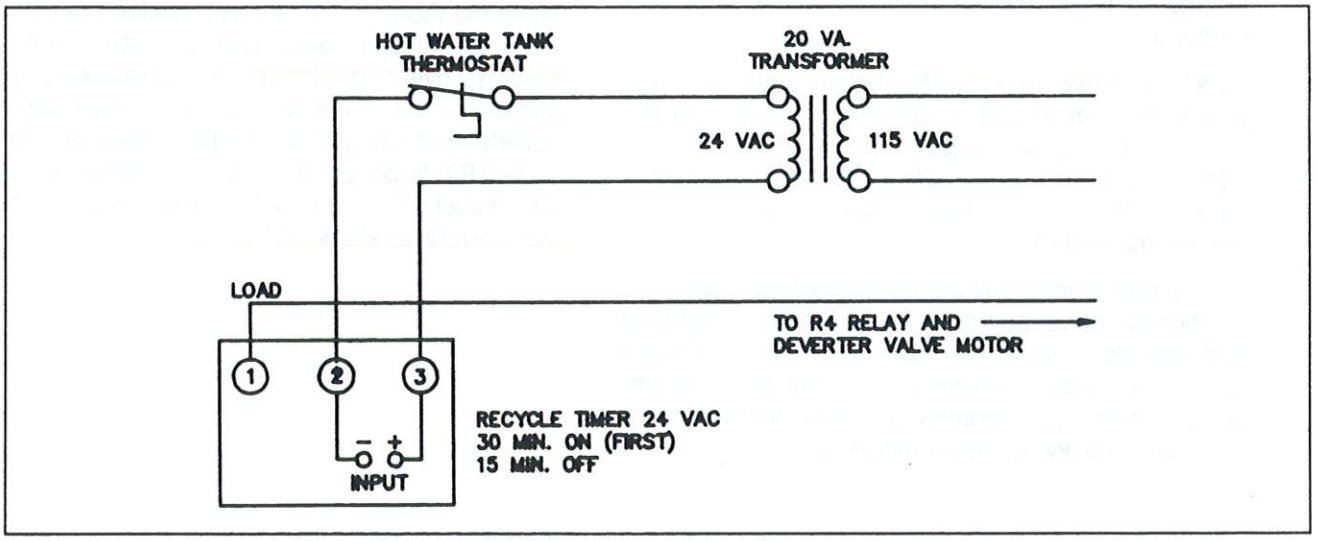


FIG. 3.5.3. *Suggested timer circuit to avoid lack of heating during long water heater run times.*

3.5.4. RADIANT FLOOR HEATING

Water temperatures in radiant floor heating systems must be kept relatively low, generally under 120°F, so that floor surfaces do not become uncomfortably warm to the touch. If radiant heating is only one application for a multi-zone system which also requires higher delivery water temperatures for other zones (i.e., water heating, baseboard, air handler, etc.) then the radiant floor zone temperature will need to be controlled separately from the boiler. If radiant floor heating is the only application for the boiler, then the boiler's internal temperature limits may be sufficient, though not redundant, if set low enough.

Mixing valves are available which will mix return water from the system with boiler output water to dilute the temperature of water transmitted to the distribution system. Mixing valves may create problems with low flow and high temperatures through the boiler unless care is taken to design a system which will provide proper flows and will fully load the boiler. Keeping the boiler's temperature high will prevent the boiler from operating at peak efficiencies. Systems which maintain boiler temperatures in this way should be avoided.

If only a portion of the boiler's available output is to be used for radiant floor heating a thermal storage tank will improve the boiler's operation and give adequate control of temperature for the distribution system.

By heating water to be distributed to the radiant floor zone to the proper temperature in an indirect-fired water heater, full load conditions will be available to the boiler because the heat exchanger in the tank can be sized to match the boiler's output. The tank's thermostat can be set at the optimum operating temperature needed by the distribution system and short-cycling of the boiler will be prevented. An insulated thermal storage tank without the heat exchanger may also be used.

3.5.5. SNOW MELTING

Snow melting systems operate in much the same way as radiant floor systems but usually are not thermostatically controlled and require the use of a heat exchange solution containing antifreeze. Antifreeze changes the pumping characteristics and specific heat of the solution. To avoid the problems associated with the use of antifreeze solutions in the boiler a thermal storage tank as described above is recommended.

Backflow preventers in the boiler feedwater line should be used if antifreeze solution is used in the boiler and may be required by local codes. Use nontoxic propylene glycol (Union Carbide UCAR 35 or equal) antifreeze only. Highly toxic ethylene glycol is not recommended.

Fill the tank and distribution piping with up to a 50% solution of antifreeze and use plain water in the boiler and tank heat exchanger loop. The heat exchanger serves to isolate antifreeze from the boiler where pumping and heat exchange problems are more likely to occur in the presence of antifreeze.

Be aware that antifreeze solution temperatures could be lower than the freezing point of the boiler water and could cause the boiler water in the coil to freeze and damage the exchanger. Using an aquastat in the tank to maintain a minimum of 40°F at all times will prevent freezing. Alternatively, the snow melt system may be set up with boiler water in the tank and the antifreeze solution running through the coil side. The relative mass of the boiler water in the tank would be too great to be frozen by the quart or so of antifreeze solution in the coil.

Best control of a snow melting system is achieved manually because heat is not required unless precipitation is occurring. Heat is not required in most such arrangements during cold, dry weather. Snow sensors are available from several control manufacturers.

3.6. STEP 6: DESIGN ZONE LAYOUT

Since the GB boiler works best under heavily loaded conditions, small zones can be detrimental to the system's overall operating efficiencies. As a general rule, make no zone smaller than one-third of the boiler's input rating. For example, zones for a GB0907 90,000 BTUH boiler should be no smaller than 30,000 BTUH each. If small zones are required use a thermal storage tank as shown in FIG. 3.6.5.

MODEL	OUTPUT BTUh	COPPER - FINNED BASEBOARD PER LINEAL FT.		STANDING CAST IRON PER SQUARE FT.	
		OPTIMUM 150° DESIGN @ 360 BTU/FT. AVG.	MINIMUM 180° DESIGN @ 550 BTU/FT AVG.	OPTIMUM 150° DESIGN @ 110 BTU/S.F. AVG.	MINIMUM 180° DESIGN @ 170 BTU/S.F. AVG.
GB0607	53,280	148	97	484	313
GB0907	79,920	222	145	726	470
GB13010	115,440	321	210	1,049	679
GB16014	142,080	395	258	1,292	836
GB0407	35,520	99	64	323	209

TABLE 4. *Optimum and minimum suggested amounts of standard baseboard radiation by boiler model.*

TABLE 4 lists the minimum amount of standard copper finned-tube baseboard radiation which should be installed for various boiler sizes. The most practical method of zoning is to incorporate all areas used at a particular time of day in a single zone to give the greatest comfort at the best possible efficiency. For example, one zone may include those areas typically used during the daytime hours--living room, dining room, kitchen, family room and baths--in one zone and those used typically at night--bedrooms--as another.

In that manner the daytime areas can be kept warm when needed and set back at other times. Likewise, cooler temperatures can be maintained in the sleeping areas. Special areas like garages or basements can be on their own zone so long as required minimum amounts of radiation are used in those zones.

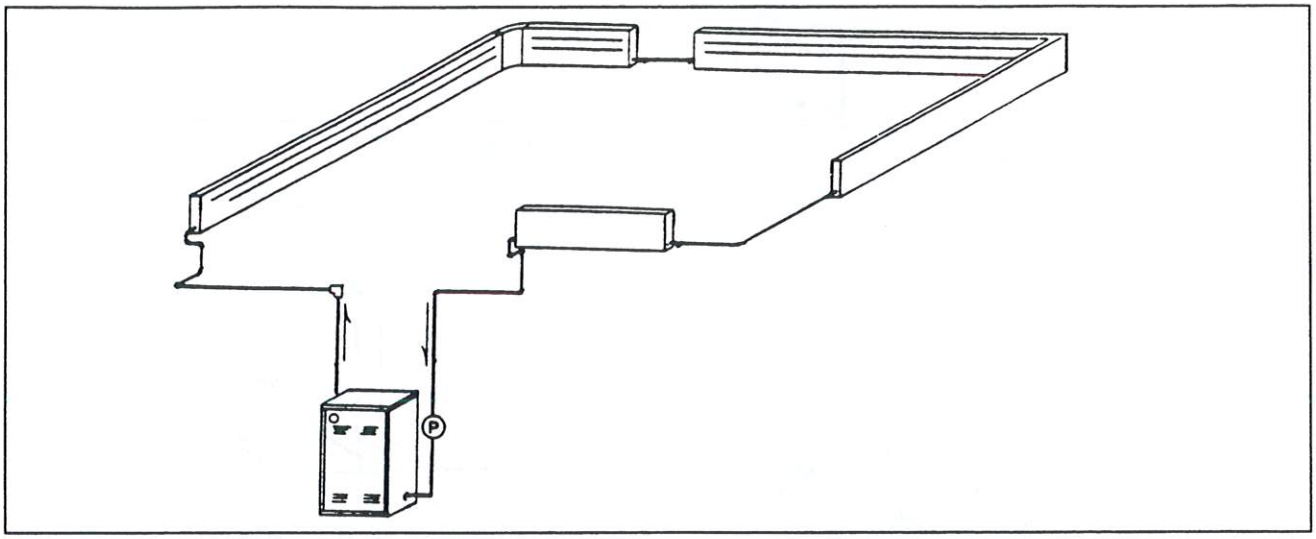


FIG. 3.6.1. *Single zone, series loop baseboard.*

3.6.1. SINGLE ZONE, SERIES LOOP

Perhaps the simplest type of system includes one zone of radiation with all distribution equipment piped in series (FIG. 3.6.1). Water is pumped through the boiler by a single system pump, out to the radiation and back to recirculate through the boiler. With this type of system no zone valves are necessary. The room thermostat will control boiler operation.

The distribution system must be able to deliver all of the output of the boiler to the heated space to avoid short-cycling and to maintain system efficiency.

Determine the length of pipe (including equivalent lengths for elbows, valves, convectors, and fittings) and choose a suitable pump to overcome the friction of the system at the required flow rate. See SEC. 3.8. for information on pumping requirements.

3.6.2. MULTIPLE ZONE, SERIES LOOPS

If multiple zone control is required a common supply or return main can be used. Individual radiators are laid out in series. Be sure to make each individual zone at least one-third of the boiler's input to avoid short-cycling of the boiler or use a thermal storage tank as shown in FIG. 2.5.4.

Multiple zone systems should include a three-way diverter valve or zone cutout relay to give water heating priority if included in the system.

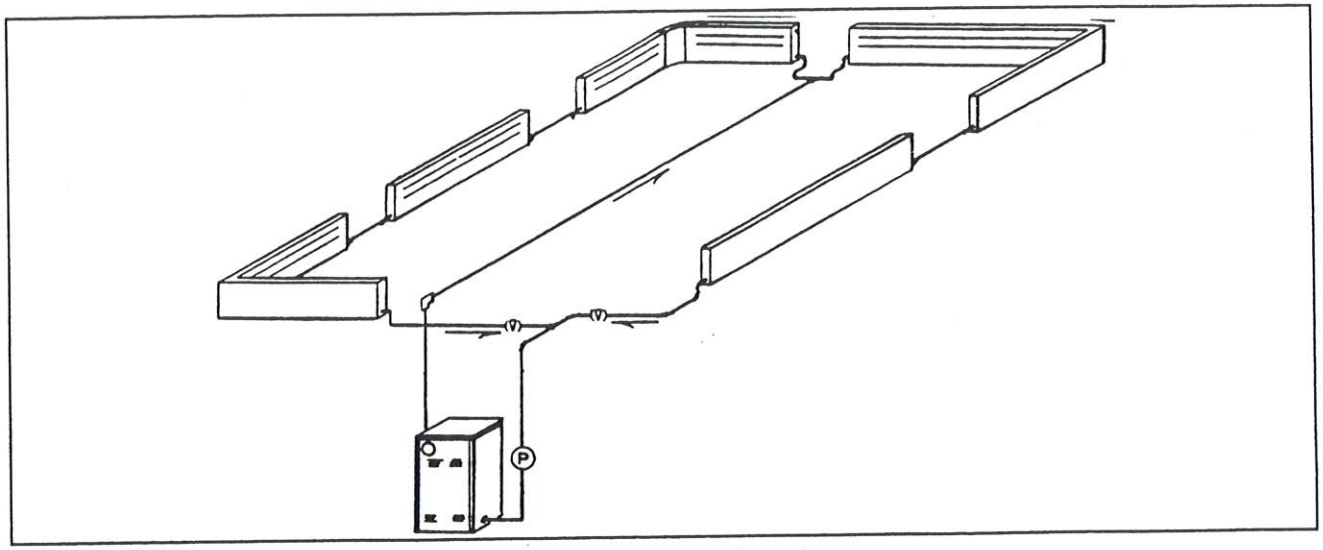


FIG. 3.6.2. *Multiple zone series loop system with common supply main.*

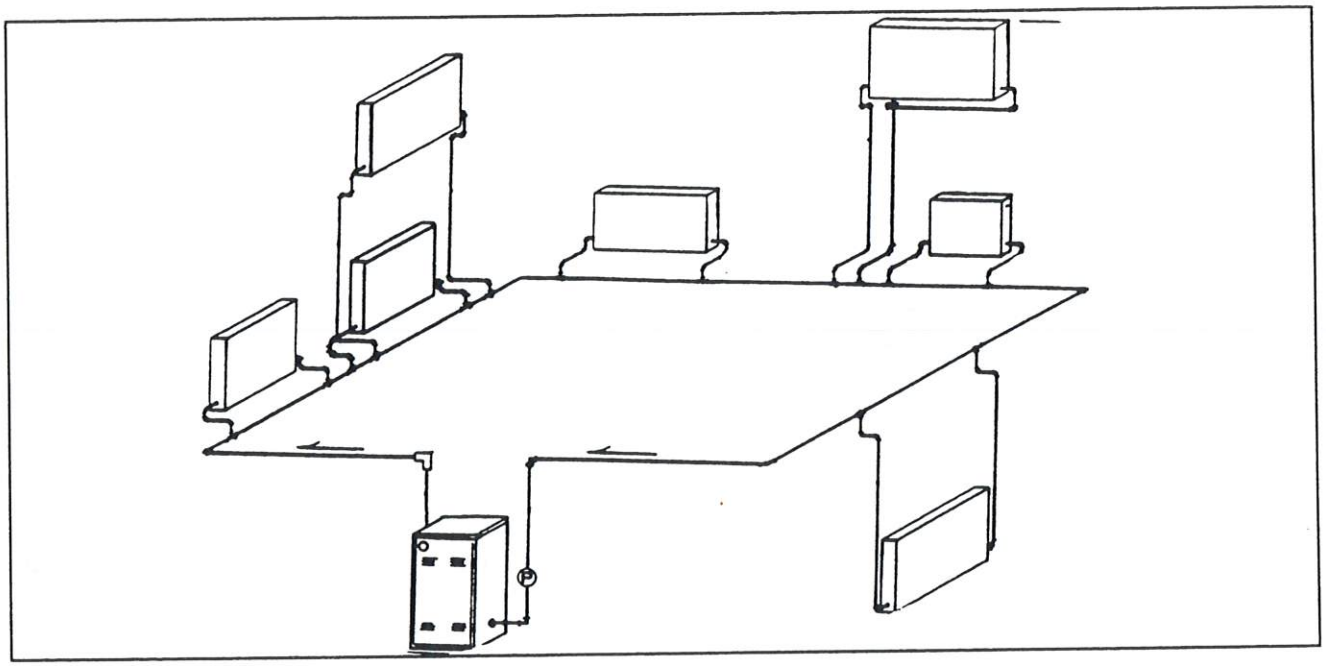


FIG. 3.6.3. *Monoflow single zone system.*

3.6.3. MONOFLOW SINGLE ZONE SYSTEMS

Monoflow systems allow for individual radiator control by providing a bypass for boiler water flow under all conditions as shown in FIG. 3.6.3.

Monoflow systems are commonly encountered in retrofit applications but monoflow fittings are still commonly available and work well in conjunction with the GB boiler.

Monoflow piping will assure proper flow through the boiler under all conditions, provided the proper pump is selected, and heat output of the radiation can be controlled on a room by room basis with the addition of automatic radiator valves.

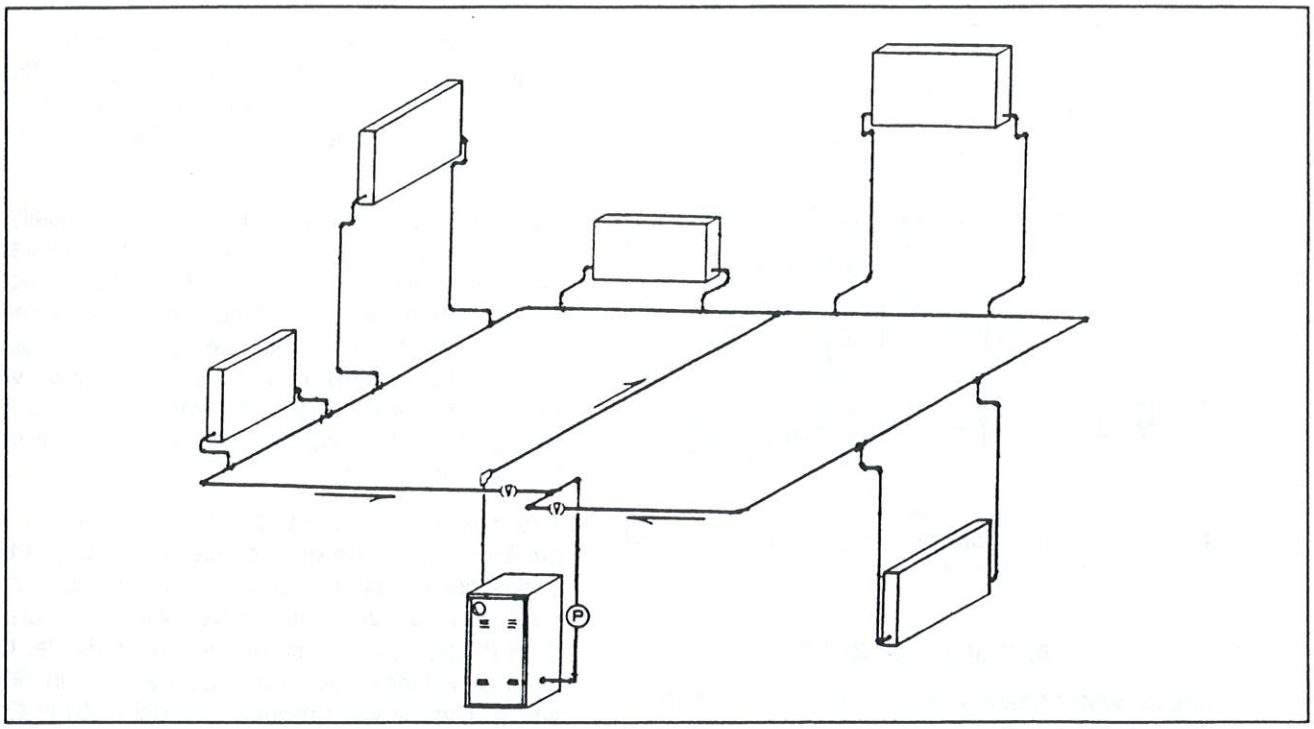


FIG. 3.6.4. *Multiple zone monoflow system schematic.*

3.6.4. MONOFLOW MULTIPLE ZONE SYSTEM

Monoflow systems may be zoned without giving up control of each piece of radiation. Supply or return mains may be common to the zones, and zone pumps or zone valves may be used depending on the system head.

Zones must not be made too small--not less than one-third of the total boiler output each--and the more radiation per zone the better the system's efficiency will be.

3.6.5. SMALL ZONE BUFFER

Since GB series boilers contain very little water, only about three pints in the boiler itself, systems which include small zones will cause excessive cycling on the temperature limit. If, for instance, a 90,000 BTUH boiler system includes a zone of only 10,000 BTUH delivery capability, any amount of heat produced beyond the 10,000 BTUH will have no outlet and will be retained in the boiler water, thus rapidly increasing water temperatures which will be sensed by the temperature limits.

Excessive cycling will ultimately increase the wear and tear on motors, ignitors, and controls and may cause premature failures within the system.

In some cases homeowners may desire individual room by room temperature control within a building. Adding insulated water storage will increase the total mass of the system and improve run times. Zones will then be supplied with heated water from the tank and the boiler will be subjected to greater loads each time the tank calls for reheating.

Water-to-water heat exchangers are not required in the tank so long as only boiler water, not anti-freeze or potable water, is contained in the tank. Use a separate tank for domestic water heating which includes a water-to-water heat exchanger.

Storage tanks should be twenty gallons or greater for best operation. Use larger tanks with larger boilers. Note that efficiencies are limited somewhat by such arrangements because of standby losses from the tank of heated water. Use tanks which are well insulated to limit the amount of standby loss.

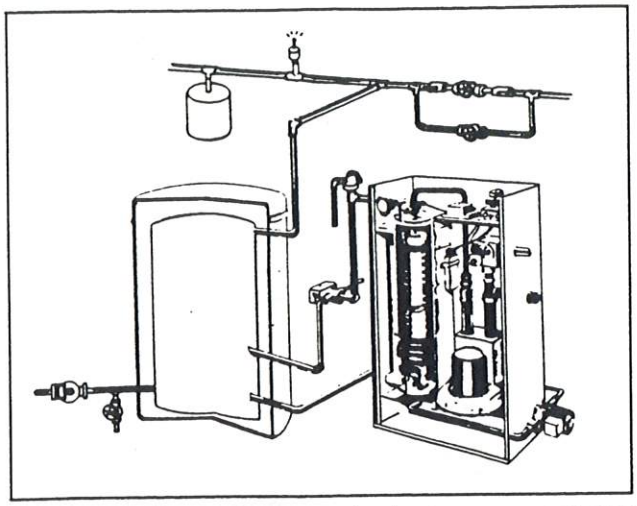


FIG 3.6.5. *Thermal storage tank gives proper boiler loading in systems using small zones.*

3.6.6. SPECIAL APPLICATION ZONES

Zones for water heating, pool or spa heating can be treated either as another zone or prioritized by using a three-way diverter valve. Domestic water heating should always take precedence over heating because the need is more immediate. A building will not cool significantly during the time needed for the average water heater reheat cycle and recovery times for water heating will be much shorter if all the output of the boiler is devoted to that one function when needed.

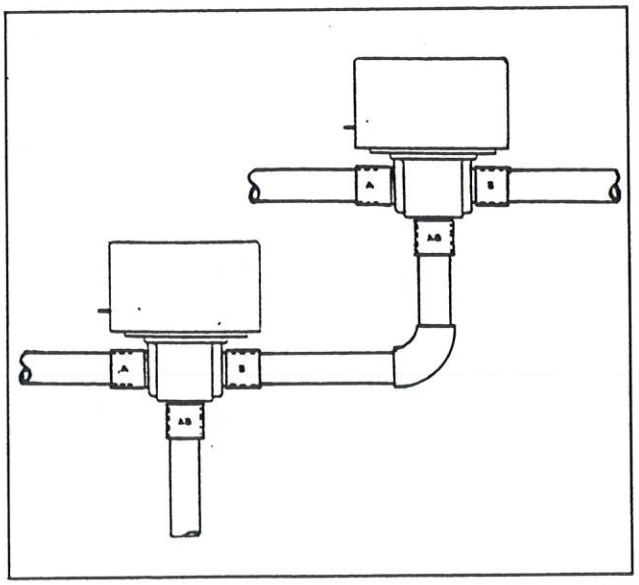


FIG. 3.6.6. *Three-way diverter valves may be used to prioritize zones to maintain performance and comfort levels.*

If pool or spa heating zones are included, they should be given last priority after domestic water heating and space heating since run times for large amounts of water will be long and cool down of the water relatively slow.

Prioritizing can be accomplished electrically with control relays, or diverter valves may be used in series to assign priorities. FIG. 3.6.6 shows prioritization of three different functions using three-way valves. When designing the system be sure to account for friction losses of the control valves. Friction losses for this type arrangement are significant and must be considered in the overall system friction calculations.

The diverter valve supplied for the furnace will produce a pressure drop of about 9' H_2O at 14 GPM and is not the best choice for the GB16014 boiler's required flow rate. Other valves with lower pressure drop (higher Cv) are commercially available. Coefficient of velocity (Cv) indicates the flow in GPM at which a valve will produce a 1 psi (2.31'H_2O w.c.) pressure drop.

Prioritization of water heating can also be achieved electrically using zone valves or zone pumps with a cutout relay activated by the water heater's thermostat circuit.

3.7. STEP 7: DESIGN PIPING SYSTEM

Each length of pipe, each fitting, each valve, and each heat exchanger will contribute friction to the water flow within the system and will need to be taken into consideration to insure proper pumping. Restriction to flow is typically measured in feet of head; the higher the system head, the greater the resistance to flow.

Using pipe sizes of 1" and larger will reduce the friction contributed by the piping. All headers and common supply and return piping should be at least 1" copper for GB0607 and GB0907 boilers, 1 1/4" for GB13010 and GB16014 boilers. Water-to-water heat exchangers and water-to-air coils must be selected to give minimal restriction as well as proper heat delivery capabilities.

3.7.1. BOILER BYPASS PIPING

Boiler water flows are critical to the operation of the GB series boiler. If flow cannot be maintained through the system piping to meet the minimums required by the boiler, the boiler bypass will allow flow to bypass system radiation and keep boiler water from flashing to steam by keeping velocities high enough for good

heat transfer. The boiler will then respond to the greater temperature rise and cycle on the temperature control. FIG. 3.7 shows the accepted boiler bypass configuration (dotted line) complete with a balancing valve to permit balancing of flows through the system and the bypass.

Pressure differential overflow valves are available which will accurately meter the amount of boiler water allowed to bypass and will react to the system's needs. These valves operate much like a pressure relief valve and will maintain proper boiler water flow over a wide range of conditions.

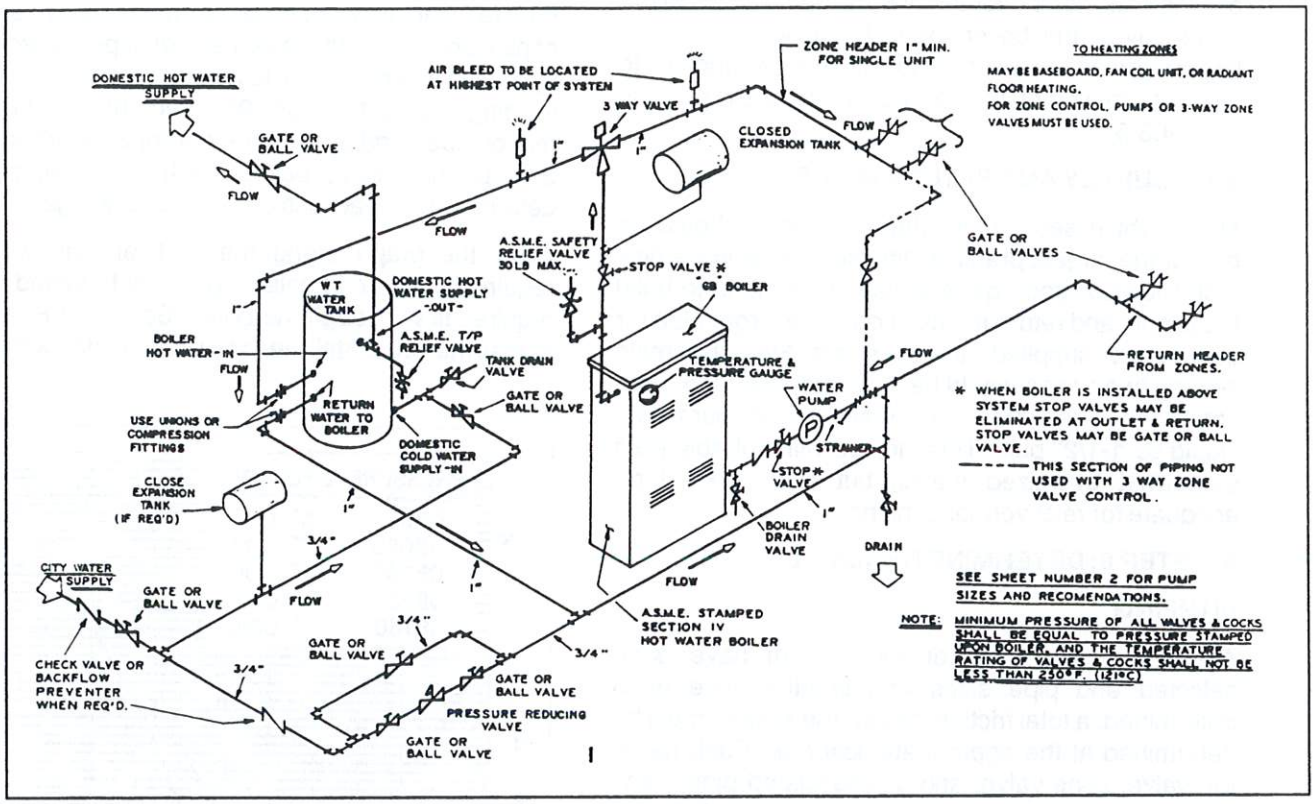

DOMESTIC HOT WATER SUPPLY
GATE OR BALL VALVE
FLOW
AIR BLEED TO BE LOCATED AT HIGHEST POINT OF SYSTEM
3 WAY VALVE
ZONE HEADER 1" MIN. FOR SINGLE UNIT
CLOSED EXPANSION TANK
TO HEATING ZONES
MAY BE BASEBOARD, FAN COIL UNIT, OR RADIANT FLOOR HEATING.
FOR ZONE CONTROL, PUMPS OR 3-WAY ZONE VALVES MUST BE USED.
A.S.M.E. SAFETY RELIEF VALVE 30 LB MAX.
STOP VALVE *
GB BOILER
GATE OR BALL VALVES
WT WATER TANK
DOMESTIC HOT WATER SUPPLY -OUT-
BOILER HOT WATER - IN
A.S.M.E. T/P RELIEF VALVE
TANK DRAIN VALVE
TEMPERATURE & PRESSURE GAUGE
RETURN HEADER FROM ZONES.
USE UNIONS OR COMPRESSION FITTINGS
RETURN WATER TO BOILER
GATE OR BALL VALVE
DOMESTIC COLD WATER SUPPLY -IN
WATER PUMP
STRAINER
* WHEN BOILER IS INSTALLED ABOVE SYSTEM STOP VALVES MAY BE ELIMINATED AT OUTLET & RETURN. STOP VALVES MAY BE GATE OR BALL VALVE.
THIS SECTION OF PIPING NOT USED WITH 3 WAY ZONE VALVE CONTROL.
CLOSE EXPANSION TANK (IF REQ'D)
STOP * VALVE
BOILER DRAIN VALVE
DRAIN
CITY WATER SUPPLY
GATE OR BALL VALVE
SEE SHEET NUMBER 2 FOR PUMP SIZES AND RECOMENDATIONS.
A.S.M.E. STAMPED SECTION IV HOT WATER BOILER
NOTE: MINIMUM PRESSURE OF ALL VALVES & COCKS SHALL BE EQUAL TO PRESSURE STAMPED UPON BOILER, AND THE TEMPERATURE RATING OF VALVES & COCKS SHALL NOT BE LESS THAN 250°F. (121°C)
CHECK VALVE OR BACKFLOW PREVENTER WHEN REQ'D.
PRESSURE REDUCING VALVE
3/4"
1"

FIG. 3.7. *Recommended schematic for GB boiler hydronic system with domestic water heating. Note that zones may be pumped or valved and bypass piping will depend on which type of controls are selected.*

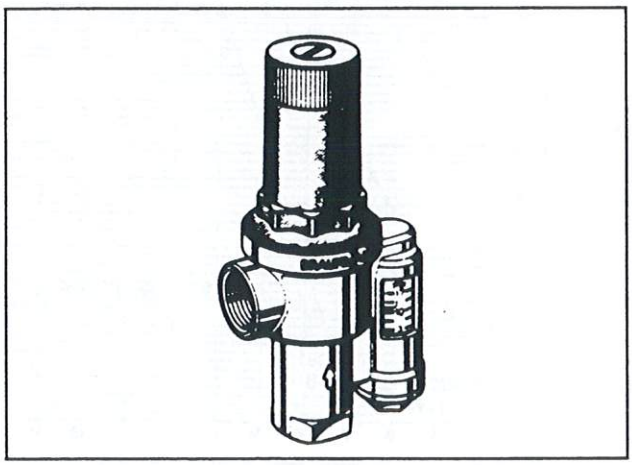


FIG. 3.7.1. *Pressure differential overflow valves will bypass only as much water as necessary under a wide range of conditions.*

3.7.2. AIR ELIMINATION

In the initial charge of water to the boiler system and in all subsequent additions of water to the system some air will be entrained or dissolved in the water. As the water is heated the air is driven out of solution and will collect in high spots in the system. These air bubbles can interfere with pumping and heat transfer and must be eliminated.

Installation of air bleed valves at the high spot(s) in the system will allow for air elimination when filling the system and will allow reventing in a day or so after all air has been driven out of solution.

Installation of an automatic air eliminator will assure that any air, even minute amounts, which subsequently enters the system will be automatically re-

moved. See FIG. 3.7 for the proper location of air vents in the system.

3.7.3. MULTIPLE ZONE HEADERS

Headers for both supply and return on multiple zone systems will help simplify the installation and subsequent servicing and balancing of systems by placing all zone controls in a central location, preferably in the boiler room. Build headers of the largest practical pipe size to minimize restriction to flow. Information on multiple boiler headers is given in SEC. 4.3.6.

3.7.4. SUPPLY AND RETURN MAINS

Mains which serve more than one zone should be built of the largest practical pipe size to minimize flow restrictions. A good general rule of thumb is to build the supply and return mains of one size larger pipe for each zone supplied. If zones are 3/4" the main serving two zones would be 1", a main serving three zones would be 1-1/4", and a main serving four zones would be 1-1/2" pipe. This method will probably yield somewhat oversized mains, but flows should be adequate for relatively long mains.

3.8. STEP 8: DETERMINE REQUIRED PUMPING

After all components for the system have been selected and pipe sizes and lengths have been determined, a total friction loss for the system must be determined at the appropriate flow rate. Each radiator, valve, zone valve, and all associated piping and fittings will contribute to the total flow restriction or head. The pump or pumps will need to provide a flow under all conditions equal to one gallon per minute per 10,000 BTUH of boiler output against the total system friction to achieve a temperature rise of 18-22°F.

3.8.1. PIPING FRICTION

SEC. 26.1 shows the friction loss of various fittings in terms of the equivalent length of straight pipe. Add all these equivalent lengths to the amount of straight pipe in the system and refer to SEC. 26.2 through 26.4 to determine the head of the piping system at the appropriate flow rate. See SEC. 2.4 for a discussion of proper flow rates for the various sizes of boilers.

After the total equivalent length of all fittings and valves in the system has been determined according to FIG. 26., calculate the total equivalent feet of pipe in the system and refer to FIG. 26.1 through 26.3 to determine the amount of system head contributed by the pipe and fittings. Add the resultant head to the boiler's head (See SEC. 3.8.2) for total system head. It is normally sufficient to determine the head of the longest zone (the zone with the highest head) to determine pump selection.

After all fittings and valves have been counted and their resistance has been converted to equivalent feet of pipe and added to the actual feet of pipe used in the system, convert the total to hundreds of feet of pipe by dividing total feet by 100 (220' becomes 2.2 hundred feet of pipe), and consult the appropriate graph (FIG. 26.1 through 26.3) based on the type of pipe to determine the head loss of piping and fittings.

Enter the graph along the vertical axis with the required flow rate in gallons per minute based on the required flow through the boiler. See TABLE 5. Read across the horizontal line to the intersection with the

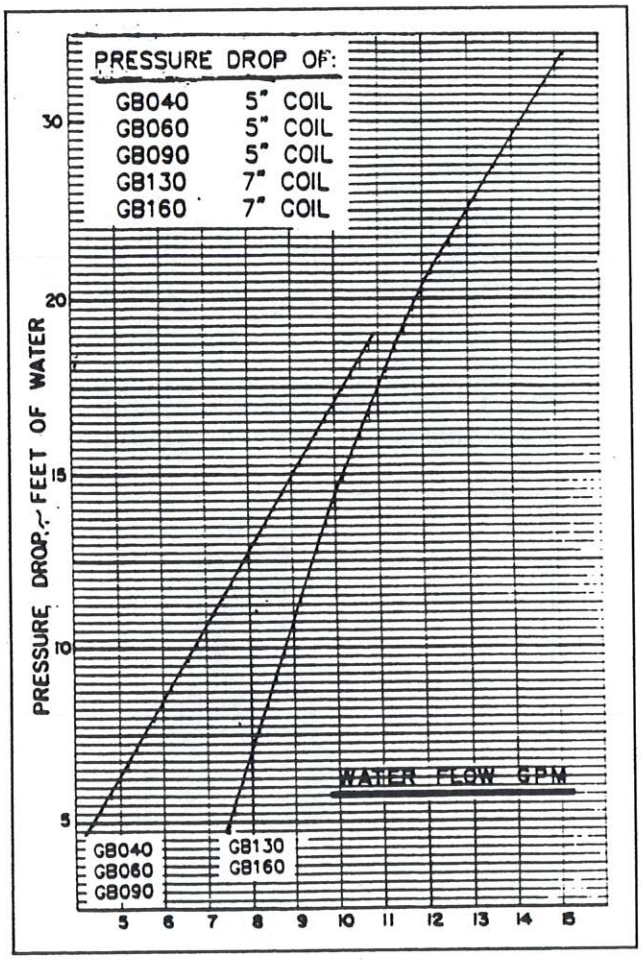


FIG. 3.8.2. *Friction loss curves for GB series boilers.*

appropriate size of pipe (diagonal line sloping upward left to right), then read straight up or down from the intersection to the friction loss in feet of water (head) per 100 feet of pipe on the horizontal axis.

Multiply friction loss per 100 feet from the graph by the number of hundred feet of pipe calculated above to determine head contributed by the piping system. Add this value to the head contributed by the boiler to determine total system head in order to select a pump.

The friction loss charts also include downward sloping lines from left to right which indicate the velocities of water within the pipe which will be produced expressed in feet per second. Flow rates above 8 feet per second are not recommended because of resulting noise and in extreme cases the erosion of the pipe.

Model	Input	Output	Minimum Flow In GPM	Pressure Drop Thru Boiler Ft. of Head
GB0407	40,000	35,600	4.0	3.25
GB0607	60,000	53,460	6.0	8.5
GB0907	90,000	79,920	8.0	13.0
GB13010	130,000	115,400	12.0	22.0
GB16014	160,000	142,080	14.0	28.0

TABLE 5. *Required flow of various GB series boilers and the resultant head to be considered when designing piping and choosing circulator pumps.*

3.8.2. BOILER FRICTION LOSS

TABLE 5 lists the resistance to flow contributed by the different boiler sizes at the proper flow rates. Use the listed flow for the boiler to design the entire piping system. These flows are critical to the operation of the boiler. FIG. 3.8.2 shows the flow curve for the various boilers.

3.8.3. SINGLE PUMP SYSTEM

If a system utilizing a single pump for all zones is desired, either a single zone system or a system using zone valves, calculate the system's total head through the longest zone and select a pump which will meet the needs of the system. Note that when only a single zone is calling all of the flow required by the boiler will need to be pumped through that zone or through the zone and bypass piping.

Enter the pump manufacturer's rating curve at the GPM required and total system head to select the proper pump. Select a pump which will meet these minimum requirements under all operating conditions. Remember to include the head restrictions of the boiler in selecting the proper pump.

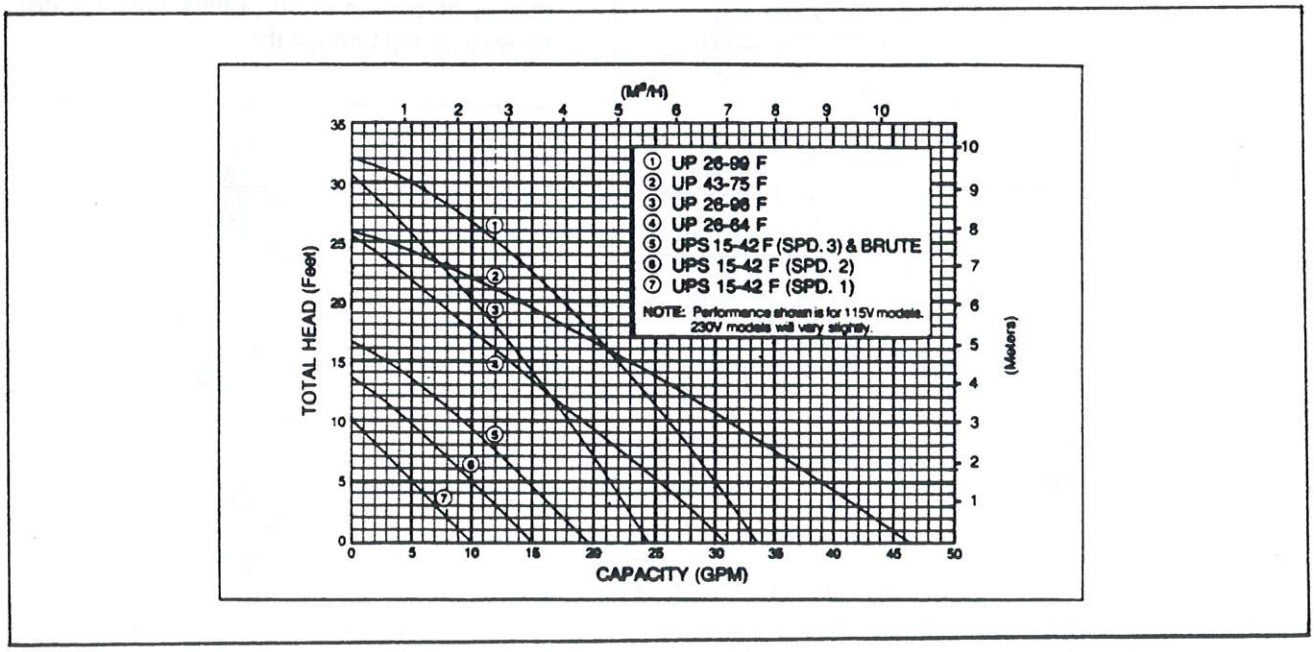

(M³/H)
1 2 3 4 5 6 7 8 9 10
35 30 25 20 15 10 5 0
TOTAL HEAD (Feet)
10 9 8 7 6 5 4 3 2 1
(Meters)
0 5 10 15 20 25 30 35 40 45 50
CAPACITY (GPM)
① UP 26-99 F
② UP 43-75 F
③ UP 26-96 F
④ UP 26-64 F
⑤ UPS 15-42 F (SPD. 3) & BRUTE
⑥ UPS 15-42 F (SPD. 2)
⑦ UPS 15-42 F (SPD. 1)
NOTE: Performance shown is for 115V models. 230V models will vary slightly.

FIG. 3.8.3. *Grundfos UP series pump curves.*

EXAMPLE: *FIG. 3.8.3 gives the pump curve of the Grundfos UP26-99F. Note that a GB0907 (90,000 BTUH input) requires a flow of 8 GPM (TABLE 5). If total system head is less than 28 feet of head at 8 GPM, then the UP26-99F will be adequate.*

If system head exceeds the capability of the pump, choose a higher head pump or design the system to require less head by using larger pipe sizes, fewer elbows and fittings, or considerusing zone circulator pumps rather than zone valves.

3.8.4. PUMPED ZONES WITH SEPARATE BOILER PUMP

When pumps are operated in series, pump head capabilities are added together at a given flow. Select a pump for each zone which is capable of overcoming the restriction in that zone at the necessary flow only. Select a boiler pump which will overcome the head of the boiler and headers only. Acting in series, the two pumps will then work in series to overcome the combined restriction of the boiler and the zone. Be sure the zone circulators and the boiler loop circulator are not undersized. Problems with heat delivery and flow will occur if the zone circulator is unable to overcome zone friction.

The boiler pump must be run anytime there is a call from the zone. The zone circulators will be operated through a relay by the room thermostat. See FIG. 3.11.1. Contactors in the relay will make the R to W circuit and the boiler's internal relay will start the boiler pump simultaneously with the combustion air blower. A double-pole, single-throw relay is provided in the boiler for this purpose.

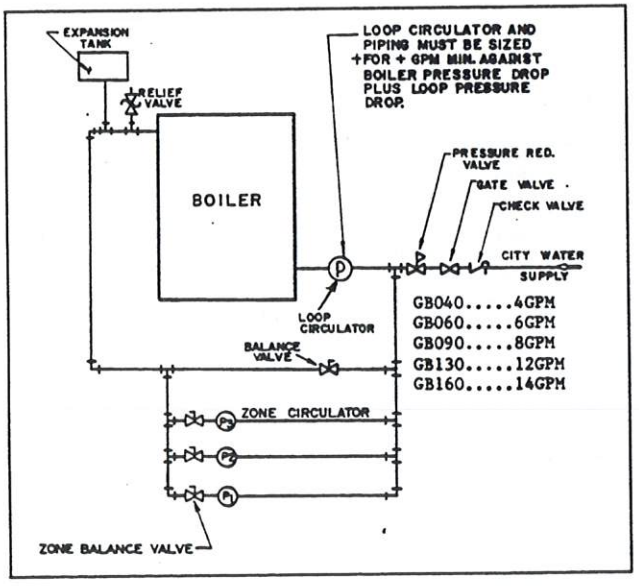


FIG. 3.8.4. *Zone circulators give optimum flow characteristics under all operating conditions. Size loop pump to boiler head, circulators to zone heads.*

A flow control valve, also called a "flow-check," must also be installed in such systems to prevent the flow of heated water through zones when they are not calling for heat.

3.8.5. BOOSTER PUMP FOR HIGH HEAD ZONE ONLY

If only one zone of a multi-zone system presents restriction which is greater than the boiler pump can overcome at the required flow, then it may be possible to add a booster pump to that zone only. Select a pump to overcome the restriction of the zone piping only and run that pump through a relay as described in the previous section. Assuming that the other zones are controlled by zone valves, no flow control valves are necessary.

3.8.6. SERIES PUMPING

In some instances it may be more practical from a cost standpoint to use two smaller pumps in series to deliver adequate head at a particular flow rather than going to a larger pump. At the same flow rate the head of two pumps in series is added together to determine total available head.

Zone and boiler pumps will act in series as described above, or two or more pumps may be installed in series to pump through the boiler.

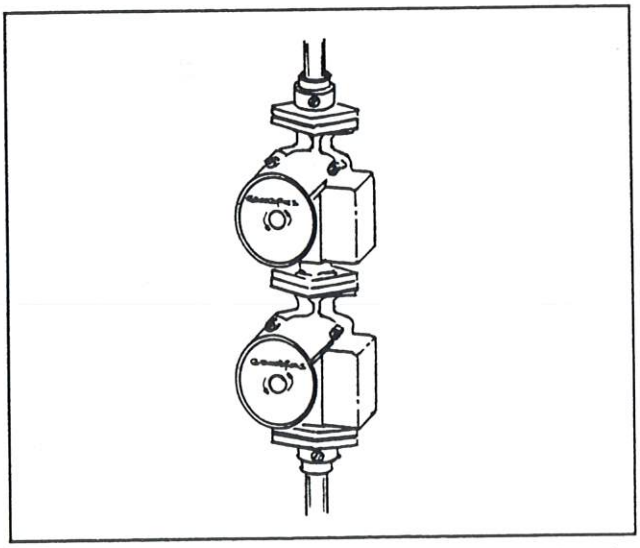


FIG. 3.8.6. *Pumps in series deliver almost twice the head at the same flow.*

EXAMPLE: *Two pumps, each capable of 23 feet of head at 8 GPM, will deliver almost 46 feet of head at 8 GPM when installed in series. Pumps may be installed back-to-back with no adverse effects. See FIG. 3.8.6.*

3.8.7. PARALLEL PUMPING

Pumps installed in parallel will deliver the same head as the individual pumps but flow will be added. Therefore, two pumps capable of 13 feet of head at 6 GPM will still only be capable of 13 feet of head but flow will increase to 12 GPM.

Zone pumps installed on a common header will deliver their combined flow rates at the calculated head of the system.

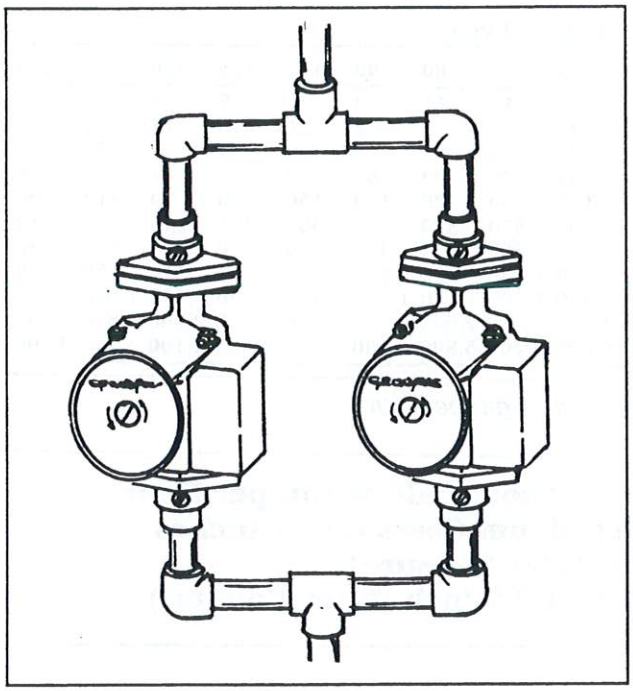


FIG. 3.8.7. *Parallel pumps deliver double the flow at the same head.*

3.8.8. SERIES/PARALLEL PUMPING

Systems which use zone circulators and a boiler loop pump combine elements of both series and parallel pumping. The zone circulators act in parallel with each other and in series with the boiler loop pump.

Size each zone pump based on the head of the zone at the required flow for that zone. A twenty degree temperature drop will require one GPM per 10,000 BTUH of radiation in that zone so a 60,000 BTUH zone will require a six GPM flow. Determine the head of that zone at six GPM based on SEC. 26. Use a pump which will meet these minimum requirements.

Size the boiler loop pump based on the boiler's friction curve and all piping, valves and fittings not included in calculations for the zone head. See TABLE 5 for head and flow needs of the different GB series boilers. Meet or exceed the minimum requirements with the pump's capability.

Zone circulators (FIG. 3.8.4) work in parallel with each other while each works in series with the boiler loop circulator.

Within certain limits excess pumping capacity will actually improve system performance. Water velocities are listed in SEC. 26. for the flows in the various sizes of pipe. Problems with noise or pipe erosion due to friction to flow in the piping will generally not appear below 8 feet per second. Heat transfer and boiler operating temperatures will be improved by slightly exceeding the minimum flows stated above.

3.9. STEP 9: DESIGN GAS PIPING

Design and install gas piping according to requirements set forth in the National Fuel Gas Code ANSI Z223.1--NFPA 54 and all the codes and regulations of the local gas supplier.

Locate a suitable shutoff valve in close proximity to the boiler to allow for interruption of gas flow to the boiler for service and repair functions. FIG. 3.9 shows the recommended configuration of supply piping, drip leg, and gas shutoff valve for the boiler.

3.9.1. NATURAL GAS PIPING

TABLE 6 lists the amount of natural gas which will pass through various sizes and equivalent lengths of black iron pipe without causing an excessive drop in gas pressure.

Incoming gas pressures must be maintained at not less than 5" of water column (maximum 10.5 ") for natural gas and not less than 11.0" of water column (maximum 13.0") for the proper operation of the gas valve. Natural gas contains about 1,000 BTUH per cubic foot at sea level. Divide boiler input by 1,000 BTUH (or BTUH value of natural gas per cubic foot as determined by the local utility) to determine required number of cubic feet of natural gas per hour.

3.9.2. LP GAS PIPING

LP gas usually contains between 2,450 and 2,500 BTUH per cubic foot. Check with local suppliers for BTUH value per cubic foot of LP gas. Divide boiler input by 2,500 BTUH (or BTUH value per cubic foot as supplied) to determine required flow rates in LP applications. TABLE 7 lists capacities in thousands of BTUH for LP gas in black iron pipe.

LP gas piping outside the building is often done with semirigid copper tubing. TABLE 8 lists capacities for LP gas in semirigid tubing.

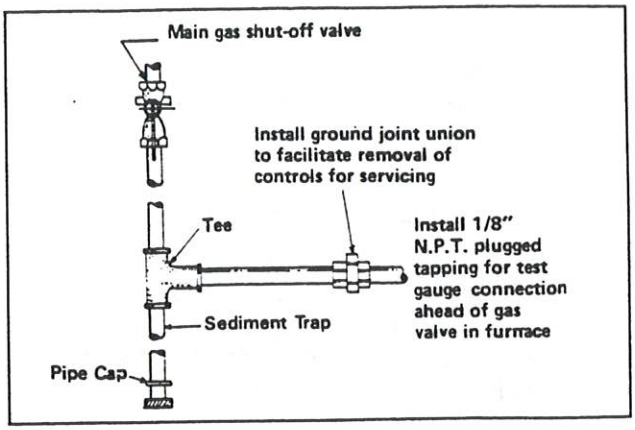

Main gas shut-off valve
Install ground joint union to facilitate removal of controls for servicing
Tee
Install 1/8" N.P.T. plugged tapping for test gauge connection ahead of gas valve in furnace
Sediment Trap
Pipe Cap

FIG. 3.9. *Gas supply piping layout.*

Nominal Iron Pipe Size, Inches	Internal Diameter, Inches	Length of Pipe, Feet													
		10	20	30	40	50	60	70	80	90	100	125	150	175	200
¼	.364	32	22	18	15	14	12	11	11	10	9	8	8	7	6
⅜	.493	72	49	40	34	30	27	25	23	22	21	18	17	15	14
½	.622	132	92	73	63	56	50	46	43	40	38	34	31	28	26
¾	.824	278	190	152	130	115	105	96	90	84	79	72	64	59	55
1	1.049	520	350	285	245	215	195	180	170	160	150	130	120	110	100
1¼	1.380	1,050	730	590	500	440	400	370	350	320	305	275	250	225	210
1½	1.610	1,600	1,100	890	760	670	610	560	530	490	460	410	380	350	320
2	2.067	3,050	2,100	1,650	1,450	1,270	1,150	1,050	990	930	870	780	710	650	610
2½	2.469	4,800	3,300	2,700	2,300	2,000	1,850	1,700	1,600	1,500	1,400	1,250	1,130	1,050	980
3	3.068	8,500	5,900	4,700	4,100	3,600	3,250	3,000	2,800	2,600	2,500	2,200	2,000	1,850	1,700
4	4.026	17,500	12,000	9,700	8,300	7,400	6,800	6,200	5,800	5,400	5,100	4,500	4,100	3,800	3,500

TABLE 6. *Maximum capacity of iron pipe in cubic feet of natural gas per hour.*

Maximum Capacity of Pipe in Thousands of Btu per Hour of Undiluted Liquefied Petroleum Gases (at 11 Inches Water Column Inlet Pressure) (Based on a Pressure Drop of 0.5 Inch Water Column)

Nominal Iron Pipe Size, Inches	Length of Pipe, Feet											
	10	20	30	40	50	60	70	80	90	100	125	150
½	275	189	152	129	114	103	96	89	83	78	69	63
¾	567	393	315	267	237	217	196	185	173	162	146	132
1	1071	732	590	504	448	409	378	346	322	307	275	252
1¼	2205	1496	1212	1039	913	834	771	724	677	630	567	511
1½	3307	2299	1858	1559	1417	1275	1181	1086	1023	976	866	787
2	6221	4331	3465	2992	2646	2394	2205	2047	1921	1811	1606	1496

TABLE 7. *Maximum capacities of black iron pipe in thousands of BTUH per hour of LP gas.*

Maximum Capacity of Semi-Rigid Tubing in Thousands of Btu per Hour of Undiluted Liquefied Petroleum Gases (at 11 Inches Water Column Inlet Pressure) (Based on a Pressure Drop of 0.5 Inch Water Column)

Outside Diameter, Inch	Length of Tubing, Feet									
	10	20	30	40	50	60	70	80	90	100
⅜	39	26	21	19	—	—	—	—	—	—
½	92	62	50	41	37	35	31	29	27	26
⅝	199	131	107	90	79	72	67	62	59	55
¾	329	216	181	145	131	121	112	104	95	90
⅞	501	346	277	233	198	187	164	155	146	138

TABLE 8. *Capacities of semirigid tubing in thousands of BTUH for LP gas.*

3.10. STEP 10: DESIGN LINE VOLTAGE ELECTRIC SUPPLY CIRCUIT

The GB boiler must be connected to a permanently live, separately fused electric circuit of proper ampacity and must be electrically grounded in accordance with local codes or the National Electrical Code ANSI/NFPA No. 70-1987. Provide a service disconnect switch in close proximity to the boiler to allow for ease and safety in servicing the unit.

3.11. STEP 11: DESIGN CONTROL SYSTEM FOR ZONES

Individual zones within a building can be controlled effectively at different temperatures and at different times of day if desired. With high efficiency boilers whose steady state efficiency increases as the total connected load increases, zoning becomes less a matter of economy than of overall comfort. Each zone can be controlled for a particular activity at different times of day.

Zone control can be achieved by using either electric zone valves (see FIG. 3.11.1 or FIG. 3.11.3) or individual zone pumps (See FIG. 3.8.4). Because of the critical nature of water flow through the boiler, the zone pump system is preferable. Since the zone pumps are installed in series with the boiler pump, better head pressures are available to overcome system friction at the necessary flow rate.

3.11.1. ZONE PUMPS

Each individual zone pump must be controlled by a zone thermostat. When there is a call for heat from the thermostat the pump will be started through a relay.

Contactors in the relay must be provided to make the R and W terminals on the boiler transformer and in turn start the boiler.

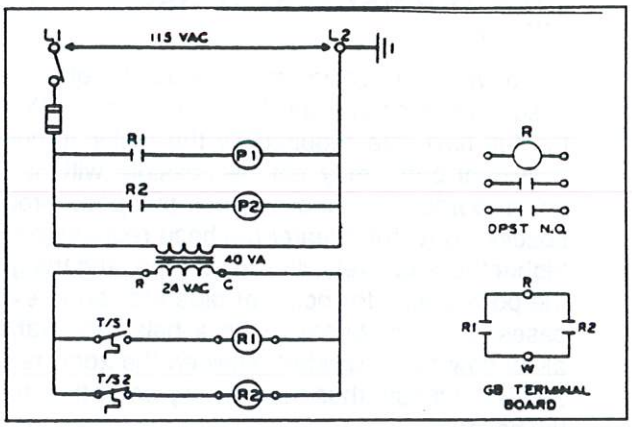


FIG. 3.11.1. *Typical wiring diagram for circulator pump zone control.*

3.11.2. THREE-WAY ZONE VALVES

Three-way zone valves may be used where the boiler pump is adequate for situations when all zones are open. Individual zone bypass piping is installed to maintain flows even when one or more zones are not operating. The zone which is calling will then only receive the flow required for that zone and excess flow is routed through the bypass piping. Balancing valves must be installed in the bypass piping to approximate the resistance of the zone when calling. This type of system will remain in balance under all operating conditions. A boiler bypass is not needed when using zone bypass.

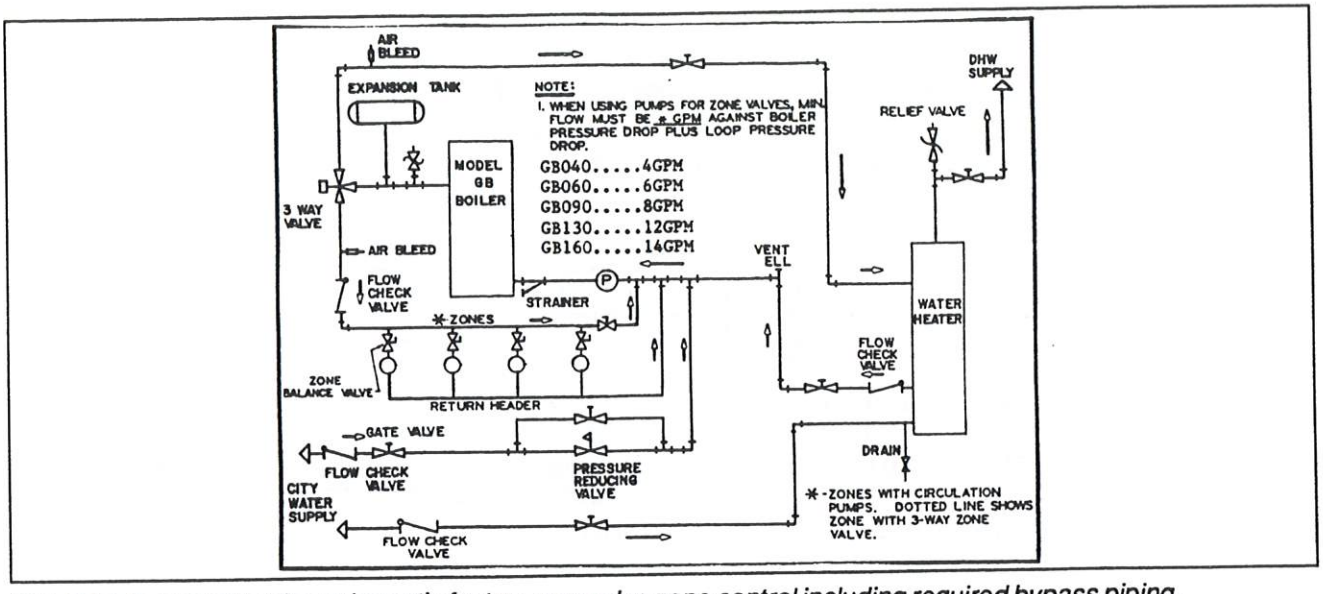


FIG. 3.11.3. *Typical piping schematic for two-way valve zone control including required bypass piping.*

3.11.3. TWO-WAY ZONE VALVES WITH BOILER BYPASS

If two-way zone valves must be used problems may arise related to flow rates through the boiler. Pumping the full flow rate required by the boiler through an individual zone may not be possible with a single boiler pump. The more water pumped through a specific zone, the greater the head requirements, the higher the water velocities in the pipe, and the greater the possibilities for noise or pipe erosion in extreme cases. A boiler bypass with a balancing valve will allow flow to be divided between the zone radiation and the bypass, thus maintaining water flow through the boiler.

This type of system is also more difficult to balance. Valve settings will be critical for the proper water delivery rates to the zones. Since the number of zones calling at any given time may vary, a balancing valve setting may or may not be appropriate under all operating conditions and the best that can be hoped for is a good compromise setting.

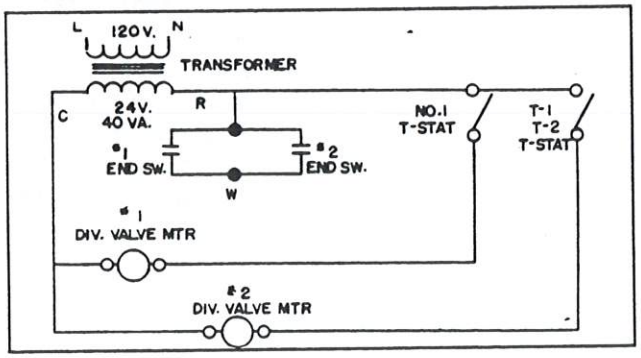


FIG. 3.11.4. *Typical wiring diagram for zone control with two- or three-way valves which include end switches.*

3.12. STEP 12: CHOOSE VENT/INTAKE CONFIGURATION

All boilers are shipped with the proper adapter to attach the required 2" or 2-1/2" CPVC and PVC exhaust and intake piping to the boiler, a condensate trap assembly, and the appropriate intake air filter

The installer may elect to vent the boiler with a separate pipe through the wall, a concentric vent/intake kit available as an accessory, or through the roof of the structure so long as overall permissible vent lengths are not exceeded, applicable codes are observed. Combustion air may be taken from inside the boiler room or from outside provided that the intake pipe terminates in the same wind load plane as the exhaust. Essentially, this means both vent and intake must terminate through the same wall or roof surface to meet code requirements.

Intake air may be taken from a ventilated attic or crawl space in such an arrangement provided no dust or harmful chemical vapors, such as those which fogs from blown-in insulation, are present which could cause the burner to plug. Ventilated attic or crawl space areas are considered indoor air for combustion since they are protected from wind loading.

UNIT	PIPE SIZE	*MAX. VENT LENGTH	*MAX. AIR INTAKE LENGTH
GB0407 GB0607 GB0907	2"	73 Total Equivalent Ft. (e.g.,25 FT. + 6,90°ELLS)	73 Total Equivalent Ft. (e.g.,25 FT. + 6,90°ELLS)
GB13010 GB16014	2 1/2" or 3"	78 Total Equivalent Ft. (e.g.,30 FT. + 6,90°ELLS)	83 Total Equivalent Ft. (e.g.,35 FT. + 6,90°ELLS)

*MIN. VENT OR AIR INTAKE LENGTH, 5 FOOT PLUS 3, 90°ELLS

TABLE 9. *Minimum and maximum vent and air intake piping lengths.*

Be sure all vent pipes slope back to the condensate tee and no low spots or sagging occurs which could trap condensate in the exhaust line. Support vent and intake piping every 2 to 3 feet and allow for pipe expansion. Insulate exhaust piping wherever it passes through an unheated space with a suitable pipe insulation to prevent condensate freezing.

Intake piping which passes through heated space may have a tendency to produce sweating on the outside of the pipe because of the cold, outside air being drawn through the pipe. Insulate the intake to prevent sweating where necessary.

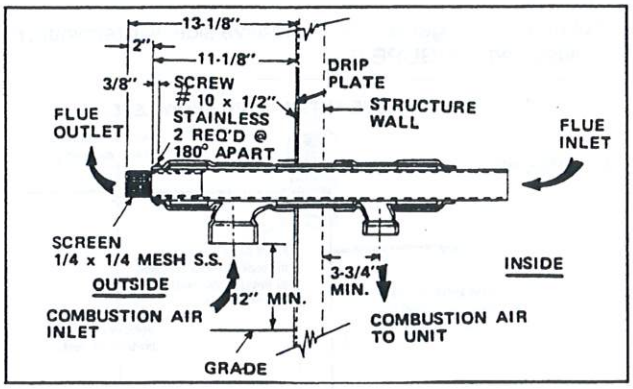


FIG. 3.12.1. *Concentric vent kit available for GB0607 & GB0907.*

3.12.1. CONCENTRIC VENT KIT

The concentric vent kit, available as an accessory, will work well in most applications. Choose a location for the vent which is not subject to swirling winds which may cause the products of combustion to be drawn in the intake. Do not locate the concentric vent in any protected corner of the building where prevailing winds may create an eddy thereby trapping the vapor and causing it to be drawn into the intake.

If side wall venting is to be used, installation should be done in accordance to the illustration in FIGURE 1. All dimensions shown in the illustrations MUST be maintained.

INSTALLATION BELOW ANTICIPATED SNOW LEVEL

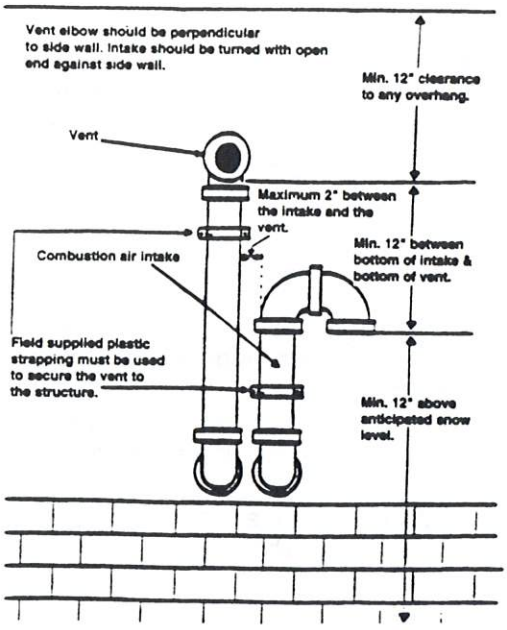
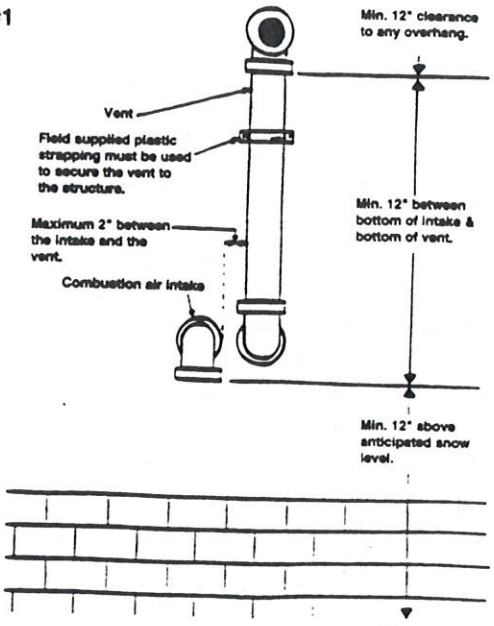

Vent elbow should be perpendicular to side wall. Intake should be turned with open end against side wall.
Min. 12" clearance to any overhang.
Vent
Maximum 2" between the intake and the vent.
Min. 12" between bottom of intake & bottom of vent.
Combustion air intake
Field supplied plastic strapping must be used to secure the vent to the structure.
Min. 12" above anticipated snow level.

FIGURE #1

INSTALLATION ABOVE ANTICIPATED SNOW LEVEL


Min. 12" clearance to any overhang.
Vent
Field supplied plastic strapping must be used to secure the vent to the structure.
Maximum 2" between the intake and the vent.
Min. 12" between bottom of intake & bottom of vent.
Combustion air intake
Min. 12" above anticipated snow level.

ALTERNATIVE SIDE WALL TERMINATION

If for some reason, combustion air and vent piping cannot be routed together, the alternative side wall termination can be carried out to maintain the proper dimensions as illustrated in FIGURE 2.

INSTALLATION BELOW ANTICIPATED SNOW LEVEL

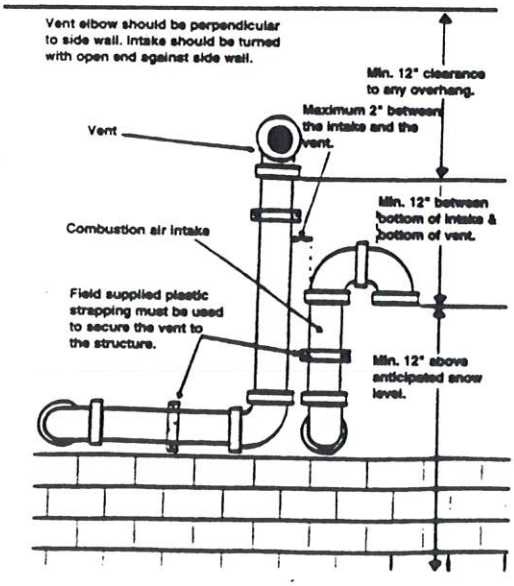

Vent elbow should be perpendicular to side wall. Intake should be turned with open end against side wall.
Min. 12" clearance to any overhang.
Maximum 2" between the intake and the vent.
Vent
Min. 12" between bottom of intake & bottom of vent.
Combustion air intake
Field supplied plastic strapping must be used to secure the vent to the structure.
Min. 12" above anticipated snow level.

FIGURE #2

INSTALLATION ABOVE ANTICIPATED SNOW LEVEL

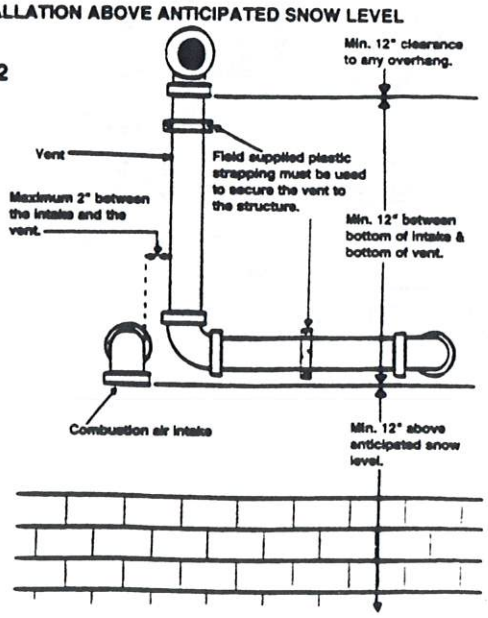

Min. 12" clearance to any overhang.
Vent
Field supplied plastic strapping must be used to secure the vent to the structure.
Maximum 2" between the intake and the vent.
Min. 12" between bottom of intake & bottom of vent.
Combustion air intake
Min. 12" above anticipated snow level.

FIG. 3.12.2. *Separate vent and intake through sidewall.*

3.12.2. SIDEWALL VENTING, SEPARATE INTAKE AND EXHAUST

Separate intake and exhaust piping is permissible provided all code issues are addressed. Code requires that the intake and exhaust terminations be at least 12" apart to avoid recirculation of the flue gases into the combustion air intake. 12" separation is often not enough to prevent recirculation. More than 3' of separation is permissible, but according to code, both intake and exhaust terminations must be in the same wind load plane, essentially through the same wall.

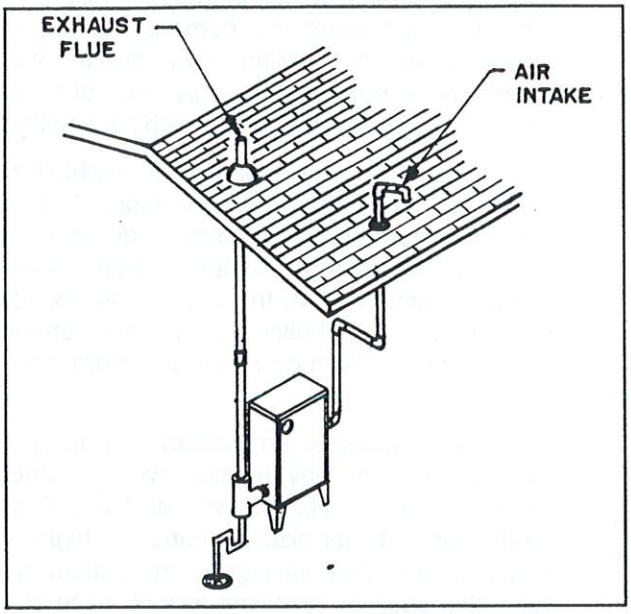


FIG. 3.12.3. *Vertical venting is permissible for venting GB boilers. Take combustion air from inside the structure or pipe to the outside in the same area as the exhaust outlet.*

Experience has shown that the two pipes may be kept immediately next to each other and that horizontal separation may be achieved by extending vent pipe at least a foot beyond the termination of the intake pipe. The wind is not as likely to blow the exhaust directly back against the wall where the piping penetration is made.

Vertical separation with the vent pipe above and extending farther from the wall than the intake also works in many situations.

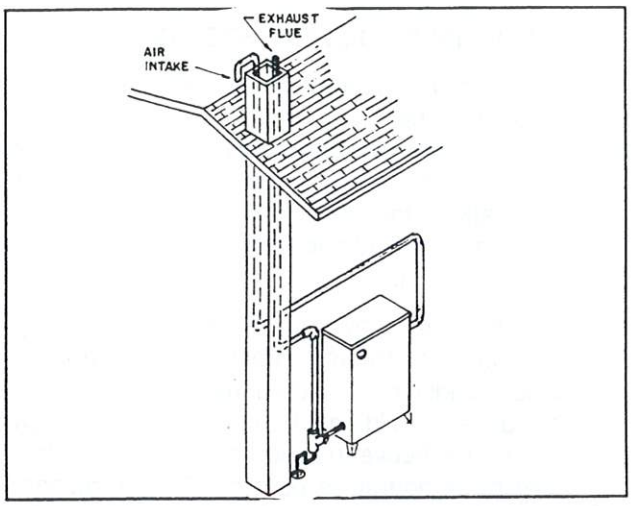


FIG. 3.12.4. *Chimneys not used for venting any other appliance may be used as chaseways for vent and intake piping.*

3.12.3. VERTICAL VENTING

In new construction, it is often preferable to vent the products of combustion through the roof. By code, combustion air must also be taken from the same roof plane or indoor air for combustion may be used. End vertical exhaust pipes straight up with no fitting on the end of the pipe. Intake termination must include a double elbow arrangement facing downward to prevent rain and snow from entering the intake pipe.

Chimneys which are not in use also offer the installer a chaseway through which to vent equipment overhead in retrofit applications. Support the pipe in the chimney to prevent the pipe from sagging or being blown from side-to-side in the chimney.

4. MULTIPLE BOILER SYSTEM DESIGN

Heat loss calculation for a structure determines the amount of heat required to keep the building at a predetermined comfort level during the very coldest weather expected in a given locale. Likewise, load calculations for systems used for other than space heating are calculated for the heaviest expected load for the system.

But the load experienced by a boiler is only occasionally close to, and rarely at, the maximum design load condition. To demonstrate this relationship, calculate a building's heat loss using a temperature differential between inside and outside environments (design temperature rise) of 70°F--corresponding to outdoor temperatures of 0°F. Then calculate heat loss for the same building using a difference of 35°F--corresponding to outdoor temperatures of 35°F, perhaps closer to the average seasonal temperatures in many areas--or choose any average temperature. At the average seasonal temperature the building's heat loss will average only about half of the calculated design load at the lowest expected seasonal temperature.

Varying load conditions are common because of the seasonal and day-to-day changes in weather conditions and by usage patterns such as night set-back. If a system has been designed to provide adequate heat when outdoor temperatures are 0°F, when outdoor temperatures are 35°F, for example, the amount of BTUs required to maintain the same comfort level will be less. Since boiler efficiency is always a function of connected load and return water temperatures, these variations can lead to significant inefficiencies.

The difference between a boiler's "steady state" efficiency and the boiler's "annual fuel utilization efficiency" or "A.F.U.E" is an expression of the effect these seasonal variations have on a boiler's efficiency. Some commercial/industrial boilers and burners have addressed this problem to some extent by employing modulating firing rates for large boilers.

But modulating firing rate burners do not address all of the inefficiencies inherent in such systems. Large boilers contain high water volumes and a great mass of metal which must be brought up to operating temperature each time there is a call for heat and subsequently radiate any heat left in boilers to the mechanical room at the end of the call for heat. In fact steel and cast iron boilers must be kept above 140°F to prevent corrosive condensate from forming on the fire side of the heat exchanger surfaces. These inefficiencies are particularly evident in the spring and fall seasons. Likewise, when the connected load involves water heating at less than full capacity, a large boiler or water heater will experience similar inefficiencies.

4.1. ADVANTAGES OF MULTIPLE BOILER CONCEPT

By installing a number of smaller boilers to meet heating demands, many of the typical inefficiencies of large boilers can be avoided. The boilers may be staged to just meet the demands of the building without over-firing. Using small boilers with less internal water volume eliminates much of the start-up and standby losses associated with large boilers.

In some cases excess capacity is desirable for pickup loads, as when buildings are brought from night setback temperatures to normal day time temperatures, or for back up should a boiler experience operating problems. In those cases excess capacity built into a multiple boiler system is not detrimental to the system's efficiency since any extra boilers are idle.

GB series boilers, when applied in a multiple boiler installation, offer advantages over all other such systems. GB series boilers provide A.F.U.E ratings of 88.8% for all boiler sizes, among the highest in the industry, and offer savings in installation and operation because of their light weight, ease of venting with plastic flue piping, mounting possibilities for floor or wall-hung applications, and their low water content and minimal mass for reduced standby losses and rapid response to any call for heat.

The GB series boiler is designed as a condensing gas boiler. That means that the boilers can operate at whatever temperature is required by the distribution system, even at the low temperatures typically required for hydronic radiant floor heating, without the need for a thermal bypass loop to protect the boiler from thermal shocking and corrosion as required by cast iron or steel boilers. GB series boilers actually become more efficient as loads increase and return water temperatures decrease. Materials used in the construction of the GB series boiler, primarily stainless steel and cupronickel, were carefully chosen for their resistance to corrosive condensates produced by high-efficiency operation.

The multiple boiler concept also provides a measure of backup heat as well. A malfunction in a single

boiler of a multiple boiler installation will have a much less disruptive effect on the heating of the building than will a malfunction in a single boiler application. Single large boiler installations which require backup heat often call for the installation of a second boiler of equal size to assure uninterrupted service. Installation costs for a multiple boiler system are frequently much less than for the same level of backup with large commercial/industrial boilers.

Typical uses for multiple boilers are schools, churches, apartment buildings, commercial and industrial building heating, water heating for laundries, food processing plants, restaurants, hotels, and pool heating to name but a few. Some larger single family residences will also benefit from multiple boiler applications, particularly multiple zone systems.

4.2. MULTIPLE BOILER CONTROL STRATEGIES

Boiler staging controls or sequencers are available which sense varying load conditions, outside air temperatures, or return water temperatures, and fire the proper number of boilers for the load. Aquastats installed in the return water line which will drop boilers out as return water temperatures rise, an indication that the load conditions are being met, are perhaps the simplest such control system for multiple boilers. Some controllers sense outdoor temperatures, domestic water demand, the number of zones calling for heat, or a combination of these criteria to precisely govern system operation.

4.3. MULTIPLE BOILER SYSTEM DESIGN

Design of multiple boiler applications, while somewhat more involved because of the number of boilers, must adhere to the same principles pertaining to a single boiler application. Only the controls or sequencers require additional consideration for proper selection and operation. The principles of water flow and connected load are the same. Distribution system designs adhere to the same criteria as for large commercial/industrial boiler systems and retrofit installations can benefit from the advantages of multiple boiler systems as easily as can a new system installation.

The following text provides the method to be followed in the design of multiple boiler installations with the GlowCore GB series boiler.

4.3.1. STEP 1: TALKING WITH THE BUILDING OWNER

Begin by defining the scope of the job, expectations and goals for the system, and present condition of the heat distribution system (for retrofit applications). Building owners may or may not be aware of the advantages of multiple boiler systems and will accept guidance and suggestions from the contractor if presented in such a way as to meet the identified needs of the building owner.

The contractor may also discover other areas which can be addressed by the system which the building owner may not have considered, particularly auxiliary uses such as water heating, snow melting, pool heating, air handlers, etc. These areas become selling points which can result in additional profit for the contractor while giving the building owner even greater savings over the long run and/or additional benefits.

4.3.2. STEP 2: CALCULATE LOADS

After defining all the tasks for which the system is to be designed, the contractor will need to develop reliable data regarding the connected load. Perform the necessary calculations to arrive at a total system load according to ASHRAE methods and data. Remember to consider any water heating or auxiliary loads which need to be met for the building.

Oversizing a multiple boiler system is less detrimental to operation than oversizing a single boiler, but initial costs may be kept lower if diversity of load is taken into consideration. For example, determine if peak water heating and space heating loads occur simultaneously. If not, size the boiler system to the heat load and allow extra capacity for water heating only if necessary.

Never install more boiler capacity than the distribution system can handle. No matter how much boiler capacity a system has, the system can only deliver as much heat as the radiation system can deliver to the environment. Undersized radiation leads to inefficiencies caused by higher return water temperatures. On the other hand, oversized radiation will only increase system efficiencies, and comfort levels will be attained with lower boiler water temperatures provided adequate boiler capacity is installed to meet the heat load.

Systems which typically run at low water temperatures--hydronic radiant floors, snow-melt systems, and pool heater exchangers for example--are excel-

ent applications for GlowCore boiler systems because of the low boiler operating temperatures. GlowCore boilers and component parts are designed to tolerate the corrosive nature of the condensate of the products of combustion and, contrary to the design of cast iron and steel boilers, condensation is encouraged because of the additional BTUs available when the gases are condensed.

4.3.3. STEP 3: SELECT THE CORRECT NUMBER AND SIZE OF BOILERS

After a total load has been determined, the designer will need to choose the correct combination of boilers to meet the load conditions. Always design the total boiler output to be equal to the total installed radiation rating or the calculated heat loss, whichever is lower. Total radiation output must be equal to or greater than the calculated load.

Either the GB 130/160 MBTUH series or the GB 60/90 MBTUH can be used in multiple boiler applications, depending on the total load, cost factors, and particularly the smallest possible demand. For instance, if small zones are to be used--zones with total radiation output less than about 80,000--consider using the GB0907 (90,000 BTUH) boilers rather than the GB16014 (160,000 BTUH). This will result in better loading conditions for the boiler when only one zone is calling for heat and efficiencies will be better. Using a large boiler to heat a single zone with a load smaller than the smallest boiler's output will cause the boiler to operate on its high temperature limit and reduce efficiencies.

Some installations yield a great deal of diversity in the loads they present to the boiler system. In those cases it may be desirable to combine a GB16014 and GB0907. In a such a system, inputs of 90,000 BTUH, 160,000 BTUH, and 250,000 BTUH can be achieved depending on the demand--three steps using either boiler or both--with only a two boiler installation. Care must be taken to assure proper flows for each boiler because their flow and head characteristics are different.

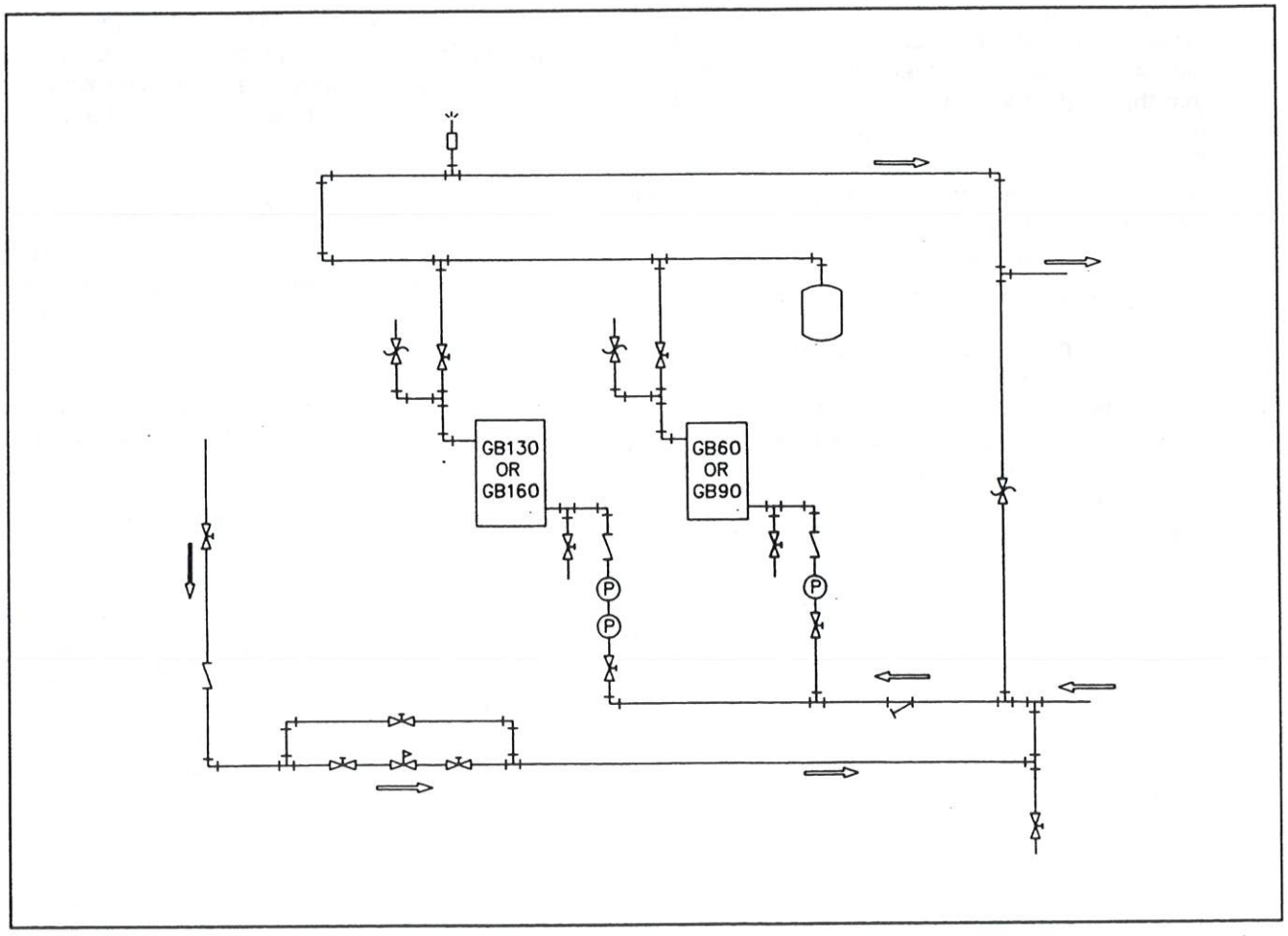


FIG. 4.3.3. *Differences in friction loss and required flows must be taken into account with boilers of different sizes in a common header.*

Most systems, however, will be adequately served by a multiple of the same size boilers, allowing for parts and service standardization, when minimum zone loads are adequate for a single boiler.

4.3.4. STEP 4: DESIGN WATER HEATING APPLICATIONS

Consult ASHRAE procedures manuals for determining water heating loads. Consider the diversity of the load--the times of day when demand will peak--when choosing boiler and tank sizes. If demands for water heating are relatively constant over long periods of time, boiler capacity must be added to keep up with the load. If, on the other hand, water heating demands peak at a given time of day then stabilize at little or no draw for the remaining periods of the day, adding storage capacity may be preferable from both a cost and performance standpoint.

For example, a hotel or apartment building presents a particularly high demand for water during the morning hours when residents are waking up and showering, then again in the evening hours at meal time and again prior to bed time. The rest of the day will be characterized by minimal draws for dishwashing, cleaning, etc., and will spread out over longer periods of time. Adding enough boiler capacity to meet those demands without adding storage capacity will result in excessive costs in a large number of extra boilers which will only run for a short period each day. The preferred solution would be to allow a limited number of boilers to run steadily all day heating a large volume of stored water to meet peak demands. Having a volume of water heated and ready for use will not limit the available draw--rate of flow--whereas without storage, draw will have to be limited to achieve the temperature rise needed in the domestic water.

EXAMPLE 4.3.4: *A contractor determines that a motel uses 1,000 gallons of hot water within a two hour period each day between 6:00 AM and 8:00 AM, then use falls to about 100 gallons per hour for the remainder of the day. The contractor then determines that to meet the demand of 500 gallons per hour at a 100°F rise will require a boiler output of 415,000 BTUH during peak demand, then 83,300 BTUH for the remaining periods. The average load per hour amounts to only 111,000 BTUH. Rather than use three GB16014 boilers in the system for water heating, the contractor can achieve the desired results by adding a 1,000 gallon storage capacity and one GB16014 boiler to meet water heating loads on demand. Essentially that one boiler has 24 hours to recover the 1,000 gallons needed for peak use while still providing adequate water for off peak use. Boilers used as the last boiler to come on in response to heating loads can be used as the first to come on for water heating which will tend to equalize run times among the boilers in the system. In this example a second GB16014 boiler may be desirable for backup and for heavier than average usage.*

EXAMPLE 4.3.5: *A commercial laundry service uses 300 gallons per hour of hot water, 24 hours a day, at a 100°F rise. Adding storage capacity will not increase the amount of available water since the demand is constant and no off time will be experienced to allow for the boiler to catch up. Ample boiler capacity must be used to keep pace with demand. In this case two GB16014 boilers or three GB0907 boilers will be needed to meet or exceed the steady demand of about 250,000 BTUH. Note that there is little to be gained by using the smaller boilers since there is little or no load diversity and the boilers will not stage off.*

The calculation to determine the BTUH output needed to meet a particular demand is as follows:

Demand (GPH) X lbs./gal of water X temp rise = BTUH of output req'd.

By definition, a BTU (British thermal unit) is the amount of heat required to raise one pound of water one degree Fahrenheit. A gallon of water weighs about 8.3 pounds. Substituting the values from EXAMPLE 4.3.5 (above) gives the following formula:

300 GPH X 8.3 lbs./gal. X 100°F rise = 249,000 BTU per hour

Output of the boiler can be determined by multiplying the boiler's efficiency of 88.8% times the input. A GB16014 boiler with input of 160,000 BTUH will yield an output of 142,080 BTUH. Match the boiler's output figure to the amount of heat required to heat the water to come up with the proper number of boilers to be used.

Like boilers, tanks too can be set up in multiples to give increased storage or heat transfer capability. Design piping carefully to insure proper flows through the heat exchanger(s) of each tank for balanced flow and proper heat exchange.

When designing applications involving the WT series water tanks, the commercial series tanks with double

heat exchangers must be used with the GB 130,000 and GB 160,000 boiler to provide adequate heat exchange surface area to deliver the available BTUs to the domestic water. A single heat exchanger tank--residential models--will not adequately load a 160,000 BTU boiler and flows through a single heat exchanger will not be adequate for the boiler's requirements. Two tanks, each with a single heat exchanger, when piped in parallel will provide adequate heat exchange surface for a single GB16014 since the two single heat exchanger tanks will present essentially the same load to the boiler as a single tank with two heat exchangers.

Take into consideration all flow rates and piping friction in the water heating system when designing piping layout. Information on piping may be found in SEC. 3.7. in this manual.

4.3.5. STEP 5: DESIGN ZONE LAYOUT

Zone configurations affect both comfort levels and boiler performance. Best comfort levels and system utilization are achieved by zoning areas to be heated only when necessary and kept at standby temperatures when not needed. However, for the GB series boilers to operate at peak efficiencies the load must match the output of the boiler system as closely as possible. Make no zone load smaller than about half the output of a single boiler when step-fired. If small zones are required, consider using a buffer tank as described in SEC. 3.6.5.

Many different types of zones are possible including both space and water heating. Air handlers, cast iron radiation, copper finned tube radiation, hydronic radiant floors, water heaters, pool heaters, and snow melt systems are all possible with a multiple GB boiler system in any combination needed.

4.3.6. STEP 6: DESIGN PIPING SYSTEM

One of the critical factors in designing a boiler system is the rate of water flow through the boilers and radiation. Without proper flow rates through the system, heat will not be delivered in sufficient quantities to satisfy the load. Without proper flow rates through the boilers, the boilers will not be able to deliver the heat present in combustion to the system and "flashing to steam", a result of the fluid moving too slowly and gaining excessive temperature in the heat exchanger, will occur. Noises associated with "flashing" will likely be objectionable and performance of the boilers will be impaired. Additionally, low flow will cause the boilers to cycle on their operating limits to excess and efficiencies will be reduced. Wear and tear on the relays, combustion air blowers, and controls will also increase and may lead to unacceptable levels of maintenance required.

The design criteria for the water flow rate for a GB boiler multiple system will be determined by the boilers in most cases. See SEC. 3.8. for required flow rates. As a "rule of thumb" use one gal per minute (GPM) of flow for each 10,000 BTUH of output for the boiler system to yield the prescribed 20°F temperature rise. Use the same rule of thumb to determine the required flow through a zone to achieve a 20°F temperature drop through the zone.

EXAMPLE 4.3.6: *Each GB16014 boiler in a system requires 14 GPM through the heat exchanger. (142,000 BTUH output divided by 10,000 BTUH per gallon = 14 GPM). Three GB16014 boilers would require a combined flow of 42 GPM (14 X 3 = 42). Zones are calculated in a similar fashion. Therefore, a 100,000 BTUH air handler will require a flow of about 10 GPM for a 20°F temperature drop in water temperature.*

The greater the amount of water moved through a pipe of given size, the greater the friction and resistance to flow. Likewise, the smaller the pipe size used at a given flow, the greater the friction loss (expressed as pressure drop or feet of head). System head also increases along with the length of pipe used. By using the optimum pipe size for the flow, friction losses can be kept to a minimum and pumping requirements will be within reason for commonly available pumps.

4.3.7. STEP 7: BOILER LOCATION

GB series boilers offer a variety of location possibilities including floor, wall, or rack mounting. They are compact and relatively light weight with a number of venting possibilities. See SEC. 3.12. for more information on venting.

4.3.7.1. FLOOR MOUNTING

All GB series boilers are shipped with appropriate leg assemblies to allow the units to set directly on the boiler room floor and are approved for use on combustible flooring. Rubber pads provided with the boilers may be placed under the legs to provide vibration damping and sound isolation. The legs provided allow ample floor clearance for a condensate drain of proper depth.

Boilers may be laid out in virtually any configuration dictated by the available space within the boiler room. Service access is not required at the back of the unit so units may be placed back to back. Required side clearance to combustibles is a minimum of one inch, although more room will be required for pumps, valves, and fittings depending on the layout chosen. A minimum clearance of 16" is recommended for service access between boilers.

Burner removal for service and adjustment requires that a minimum of 16" clearance be provided above the boiler. All other service is accomplished through the removable front panel. Maintain at least 6" front clearance from combusti bles. GB boilers are approved for closet installation. If closet doors can be opened to gain access to the front panel a 6" clearance is permissible. Allow at least 36" from the front of the unit to any fixed walls or other equipment to allow for convenient service access to the boiler's cabinet.

4.3.7.2. WALL MOUNTING

Because of the GB series boiler's 0" back clearance to combustibles and relatively light weight, the boilers may conveniently be mounted on either combustible or non-combustible walls. Observe front and side clearances listed above for service access. Boilers must be wall-mounted at least 10" above the floor or other obstruction to allow for an adequate condensate trap.

If overhead clearance is available in the boiler room boilers may be mounted above each other to take maximum advantage of wall space. Top, side, and bottom clearances for service access as listed in SEC. 5.1.1 above must be maintained.

Metal strut or angle material may be used to facilitate the mounting process. Affix slotted angle or channel securely to the wall and bolt the boilers through the cabinet back to these angles. Mounting holes must be drilled in the cabinet back to allow wall mounting. Boilers may also be lag bolted to walls. Rubber isolation pads provided with the boilers may be inserted between the boiler and the wall or strut material to limit sound and vibration transmission through structural members.

4.3.7.3. RACK MOUNTING

Boilers may be mounted on rack systems if desired. Racks may be built of welded or bolted metal and must be strong enough to prevent the boilers from exerting weight on the piping system. Boilers may be mounted back to back and/or side by side and/or over and under each other to take maximum advantage of available space. Anchor the rack securely or provide appropriate legs to provide a stable base.

Maintain side, front, and top service clearances listed above and pay special attention to sound isolation to prevent vibrations from being transmitted to the building's structural components.

5. SINGLE BOILER INSTALLATION

The following sections provide specific recommendations and detailed instructions to be followed when installing the GB boiler.

5.1. LOCATING THE BOILER

The GB series boiler can be located virtually anywhere desired provided that all code considerations are met. Because of the boiler's compact size and venting flexibility, the installation is not limited to a boiler room setting. Before locating a boiler near a living space consider whether the sounds generated by the combustion air blower will be objectionable. Sound levels from the boiler are no greater than from any other type of high-efficiency boiler but even minimal levels may be objectionable if located near a bedroom or in a living area.

5.1.1. CLEARANCES TO COMBUSTIBLES

TABLE 10 indicates the minimum clearances required by national codes. Local codes may differ but most local codes will require that the following clearances established by A.G.A. be the operative guideline. The GB series boiler is designed for zero clearance to combustibles but be sure to allow adequate space for service access to the unit. All units are design certified by A.G.A. for installation on combustible floors and for closet installation.

BACK	FRONT	FLUE	TOP OF BOILER	SIDE
0"	6"	0	16"	1"

TABLE 10. *Minimum clearances to combustible materials.*

5.1.2. SERVICE CLEARANCES

Virtually all service work on the GB series boiler can be accomplished through the front door and top panel of the cabinet. Side clearance is required only for piping and electrical connections. No rear clearance is necessary. Side clearances are to be a minimum of 8" where access for cleaning and servicing are required.

At least 16" should be allowed above the top panel of the control compartment to allow for the removal of the burner from the boiler assembly. This top panel is removable and makes servicing the unit easier. Do not attach anything to the top panel which would prevent service access.

5.1.3. AMBIENT CONDITIONS

All GB series boilers are designed for indoor installations. Ambient conditions will affect the selection of heat transfer solution and the handling of condensate drainage.

When GB series boilers are installed in space which is kept above a minimum 32°F, water is the recommended heat transfer solution and no special considerations are needed. Most installations fall into this category. When the potential for the boiler to be subjected to freezing temperatures exists care must be taken to insure that the heat transfer solution not be allowed to freeze. Commercial antifreeze solutions of propylene glycol are available which will insure that the boiler will not be damaged by freezing conditions. Freeze damage is not covered under GlowCore warranty and it is the exclusive responsibility of the installer to assure freeze protection in such cases.

Addition of antifreeze to the system will increase the pumping requirements dramatically for proper operation since antifreeze reduces the heat absorption ability of the heat transfer solution. Increase flow rates through the primary heat exchanger by 10% for solutions containing 20% propylene glycol and increase available head of the pump 23%. 20% is the highest amount of antifreeze recommended for use in the boiler. Freeze protection will be about 17 deg. F at 20%, the point at which the antifreeze will form icy slush but not burst pipes.

EXAMPLE: *A boiler heat exchanger which requires 8 GPM with plain water will need 10% more flow or 8.8 GPM and the head produced by the system will be 23% higher than the same 8.8 GPM flow of plain water. The GB0907 heat exchanger produces a head of of about 15'of H_2O at 8.8 GPM with plain water, but with antifreeze figure pump head at 23% more or about 18.5' of H_2O. An external pump with higher flow and head will be required for the system.*

Additional consideration must be given to the condensate trap and drain piping to insure that freeze up does not occur in the condensate line causing the boiler to shut down on its safety controls. An electric heating cable approved for use on plastic pipe and pipe insulation must be added to protect the condensate line from freezing.

5.1.4. FLOOR MOUNTING

GB series boilers are shipped with an optional leg assembly which may be used on combustible or noncombustible floors. The legs will give adequate clearance above the floor for the installation of the condensate trap.

Attach the legs with the screws provided with the boiler. Rubber isolation pads provided with the boiler may be installed on the floor under the boiler's legs to prevent the transmission of vibrations associated with the combustion air blower to the floor of the structure.

5.1.5. WALL MOUNTING

Since the GB boiler requires no back clearance to combustibles, the boiler may be hung on most walls. Consider using metal angle or channel between the wall and the boiler which will allow the unit to stand out from the wall, particularly on concrete walls, thus preventing moisture in the wall from rusting the cabinet over time. Allowing some space between the boiler cabinet and the wall will permit air to circulate between the wall and the boiler cabinet and will allow adjustment for irregularities in the wall surface.

Rubber isolation pads provided with the boiler should be inserted between the boiler and mounting hardware to prevent the transmission of vibrations associated with the combustion air blower.

5.2. SOUND ISOLATION

The GB boiler's combustion air blower creates some vibration within the unit. The cabinet has been insulated to limit the transmission of sound to the environment, but in some cases it may be necessary to limit sound further. In those cases, the following steps should be taken in addition to the installation of isolating mounting pads as described in 5.1.4. and 5.1.5. above. See FIG. 5.2.0.

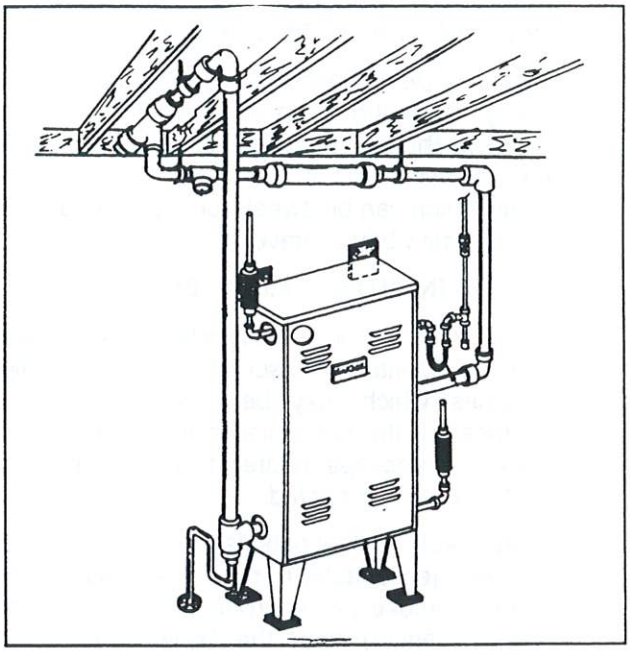


FIG. 5.2.0. *Sound isolation procedures.*

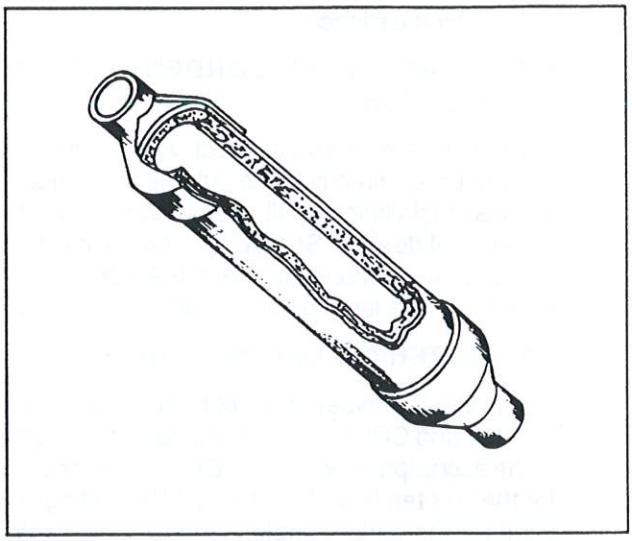


FIG. 5.2.4. *Inline intake muffler may be used for indoor or outdoor combustion air where necessary.*

5.2.1. FLEXIBLE GAS CONNECTOR

Rigid steel gas piping may be isolated by means of a flexible gas connector listed by A.G.A. for use with central heating equipment. A suitable connector is provided with each GlowCore unit.

Flexible connectors must be entirely in the same room as the boiler and may not penetrate a wall, floor, or ceiling. Install the connector so that it is not stretched out straight but has ample length to allow a u-shaped bend to absorb vibration. Refer to ANSI Z21.24 or ANSI Z21.45 for regulations regarding flexible connectors.

5.2.2. ISOLATING PIPE SUPPORT

Isolation hangers may be used on all vent, intake, supply, and return piping to the boiler to prevent the transmission of sound through the structure to which it is attached. Use rubber pipe insulation between the hanger and the pipe to prevent metal-to-metal contact. Insulate around any pipe which passes through a joist or penetrates a wall or floor.

5.2.3. PIPE VIBRATION ELIMINATORS

Flexible pipe connectors may be installed in the supply and return lines to prevent transmission of vibrations through the heat distribution system. These are typically made of corrugated brass or copper tubing which can be sweat connected into the piping and will limit vibration travel.

5.2.4. INLINE INTAKE MUFFLER

The air intake piping of the combustion air blower may emit a resonance associated with the high air velocities which may be objectionable in some instances. If the GB boiler is installed with a water heater or pool/spa heater run time during warm weather can be expected.

Sound levels present outside the building at the intake may be objectionable. To minimize intake noise install an inline intake muffler (part no. CBS, combustion blower silencer) near the boiler, preferably in a vertical run of the 2" PVC intake line. If installed horizontally moisture could be trapped in the low spot created by the silencer.

5.3. VENT/INTAKE/CONDENSATE PIPING INSTALLATION

GB boilers are listed as direct vent heating devices and are piped directly to the outside for combustion air in most installations. All are approved for use with indoor air if desired. See SEC. 5.3.6 for information on indoor air for combustion. TABLE 9 lists minimum and maximum vent lengths for the GB series boilers.

5.3.1. MATERIALS OF CONSTRUCTION

The approved materials of construction are schedule 40 PVC and CPVC pipe in the sizes and lengths listed in the accompanying charts. CPVC pipe must be used for the first ten feet of vent and CPVC fittings must be used for the outlet adapter (supplied with boiler) and for the vent outlet/condensate drain tee.

5.3.2. ALTERNATE MATERIALS OF CONSTRUCTION

Other materials must be code approved for the type of application in which they are employed. High temperature plastic pipes such as Hart & Cooley's "Ultravent" and Plexco's "Plexvent" are acceptable if local codes permit and size and length of piping are consistent with the chart.

5.3.3. ASSEMBLY PRACTICES

Remove all plastic debris and burrs when installing intake piping. Plastic filings caused by cutting PVC pipe must not be allowed to be drawn into the combustion air blower. Debris from the assembly process will jam the blower impeller and cause blower failure because of close tolerances in the combustion air blower. Blower failure which is determined to be caused by plastic filings in the blower will not be covered under warranty.

All joints must be made secure with PVC and CPVC solvent cement and checked for tightness. Flue gas vent pipe connections should be checked with soap and water solution with the combustion air blower running and the vent blocked. A no-hub fitting may be used where the air intake line is connected to the boiler or the fitting may be assembled without glue to allow for easy removal should service to the combustion air blower be required.

In the concentric vent kit, do not cement the pipe to the reamed reducers which center the exhaust pipe to allow for expansion of the tubing.

Slope the vent line back to the condensate tee at a rate of 1/2" per foot of horizontal run. Support plastic pipe every two to three feet.

5.3.4. CONDENSATE DRAINAGE

Condensate lines may be either 1/2" PVC or CPVC. A plastic union is recommended in the 1/2" condensate drain trap to allow the removal of any sediment in the trap and to facilitate some service and troubleshooting procedures. Slope the condensate drain line toward the floor drain at a rate of 1/2" per foot of horizontal run. A condensate pump approved for use with condensing gas-fired equipment may

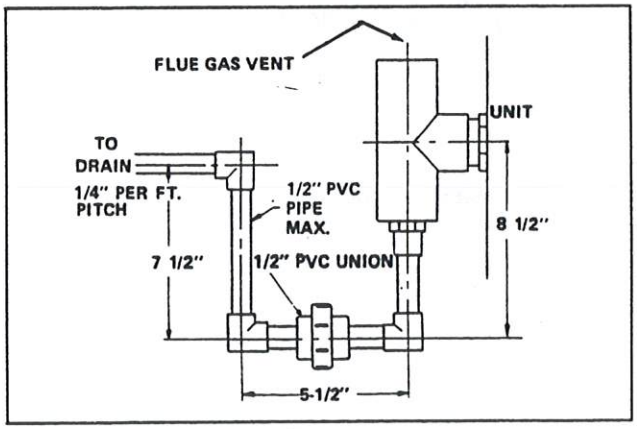


FIG. 5.3.4. *Condensate trap must be at least 7-1/2" deep to maintain proper water seal.*

be used if no floor drain is available.

To prevent the escape of exhaust gas through the condensate drain line, a trap must be installed to maintain a water seal of at least 7-1/2" depth. See FIG. 5.3.4 for trap dimensions.

5.3.5. COMBUSTION AIR FILTER

Combustion air filters are provided with each GlowCore unit [p/n 1850002 (old p/n 704-5370), replacement element p/n 1850001, old p/n 704-5369)] to prevent dust and dirt from entering the burner. The combustion air filter will prevent plugging of the burner caused by dirt being trapped in the burner's outer mesh covering. The filter element supplied with the filter (1850001) is not designed to be weather resistant and is approved for indoor use only.

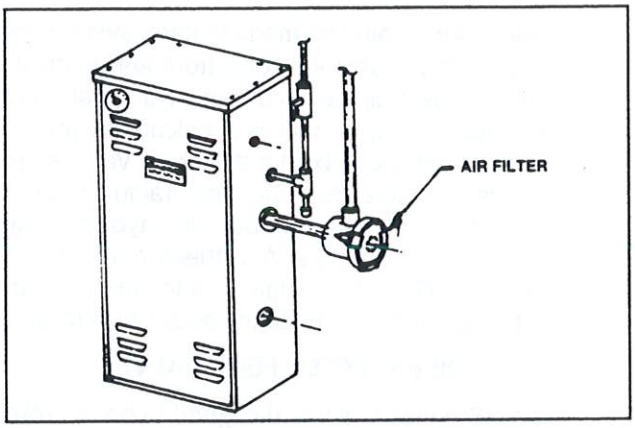


FIG. 5.3.5. *Air filter must be installed to prevent the burner from becoming clogged in dusty conditions.*

5.3.6. INDOOR AIR FOR COMBUSTION

Provide adequate ventilation for the boiler room to provide combustion air if indoor air is used for combustion. National Fuel Gas Code (ANSI Z223.1, SEC. 5.3.3) requires a minimum of 1 square inch per 4,000 BTU of input of free area when air is drawn directly from outside to the boiler room. Note that minimum vent/intake lengths must still be observed for proper operation.

5.4. ELECTRICAL CONNECTIONS

See TABLE 11 for the electrical ratings for the various sizes of GB boilers. Design a separately fused, permanently live circuit of proper ampacity for the boiler, circulator pump(s), and accessories. Install a junction box on the outside of the boiler cabinet where the knockout is provided for electrical service.

Provide a suitable service disconnect switch on the junction box for safety and convenience when servicing the unit.

See SEC. 22. for wiring diagrams and various control and configuration options.

5.4.1. ELECTRICAL CODE CONSIDERATIONS

Boilers must be electrically grounded in accordance with the National Electrical Code ANSI/NFPA No. 70-1987 and all local codes. Wiring to be done in the field between the boiler and devices not attached to the boiler, or between separate devices which are field installed, shall conform with temperature limitation for type T wire (63°F. [35°C.] rise).

Model Number	GB0407	GB0607	GB0907	GB13010	GB16014
Burners (No.)	1				
Electrical Data (Volts/Hz/Ph)	115/60/1				
F.L.A.	3.2 Amps				
Transformer Size (VA)	40				

TABLE 11. *Electrical ratings of GB series boilers not including pumps.*

5.4.2. LOW VOLTAGE WIRING

The 40 VA transformer installed in the boiler is intended only for the boiler's internal control. Diverter valves, zone valves, and zone pump relays must be provided with a separate transformer. A separate junction box should be installed to mount the transformer.

Thermostat and low voltage control wiring to zone valves or pump relays may be 18 or 20 ga. copper thermostat wire depending on the length of wire run.

5.5. GAS PIPING

All gas piping for GB series boilers must comply with National Fuel Gas codes and ANSI standard Z223.1 and the requirements of local utilities. Refer to TABLE 6 or 7 for capacities of gas piping.

Install an approved shutoff valve, ground joint union, and drip leg as indicated in FIG. 3.9.

Be certain to install a pipe of large enough diameter to minimize pressure drop in the line when the boiler is running. A gas line which is too small will show the proper pressure when the boiler is not running but pressures will drop dramatically when the boiler's gas valve opens and may create problems because the pressure regulator cannot pass enough gas for the burner to fire within the necessary range.

5.5.1. MINIMUM/MAXIMUM NATURAL GAS PRESSURES

Natural gas pressures ahead of the gas valve must be maintained between 5.0 and 10.5" w.c. while the boiler is running. Gas pressures above or below these levels will lead to problems associated with the gas valve's internal pressure regulator.

5.5.2. MINIMUM/MAXIMUM LP GAS PRESSURES

LP gas pressures must be maintained between 11.0 and 13.0" w.c. ahead of the gas valve while the boiler is running.

Gas pressures above or below these levels will lead to problems associated with the gas valve's internal pressure regulator.

5.6. HOT WATER DELIVERY PIPING

All piping must be installed in accordance with all applicable local, state, and national codes for forced hot water heating systems. Consideration must be given to pipe capacities and pressure drop through the piping.

5.6.1. SERVICE VALVING

Valves to isolate each boiler circuit are recommended. Valves in each circuit are needed to balance flows of unequal zones and will help in servicing, filling and purging the system. Purge valves which consist of a ball valve and a drain valve are especially useful when filling the system and purging air, as well as circuit balancing. Pump flanges which include ball valves may be used as system service valves if positioned properly in the system. See FIG. 3.7.

Every effort should be made to keep system pressure drop to a minimum for a quiet, trouble-free installation. Use full flow ball valves or gate valves and consider the pressure drop of valves in calculating total system head. Information about a particular valve's pressure drop is available from the manufacturer. SEC. 26.1 gives representative values for typical valves in equivalent feet of pipe. Add these numbers together and see FIG. 26.2 through 26.4 to convert equivalent feet of pipe to feet of head at specific flow rates.

5.6.2. BOILER WATER FEED VALVE

The GB series boiler is designed to be operated as a closed system under low pressure. The water pressure switch will not allow the boiler to run unless at least 9-12 psi pressure is present to close the switch's contacts. To maintain the necessary pressure, install a pressure reducing valve which will drop household water pressure from the normal 40-80 psi to no less than 9-12 psi. If pressure is not reduced, household water pressure will be sufficient to open the pressure relief valve.

Water feed valves consist of a spring and diaphragm to control water pressure. Some are equipped with a fast feed override (see FIG. 5.6.2) which can be used when filling the system, or a bypass arrangement may be used (see FIG. 3.7). After the system has been completely filled and air has been eliminated, the water feed valve will only be required to keep a constant static pressure on the system.

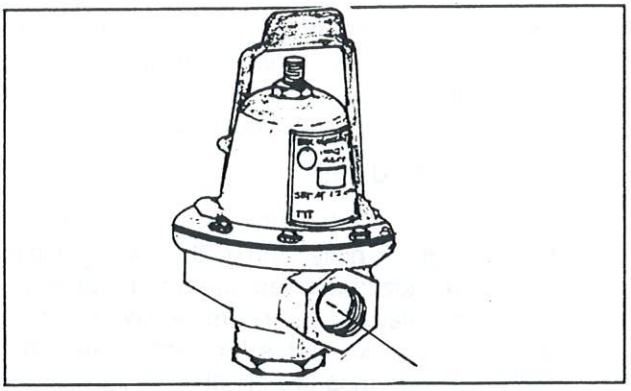


FIG. 5.6.2. *Pressure reducing boiler feed water valves maintain a constant pressure in the system. Bypass piping allows quick system filling.*

5.6.3. BACKFLOW PREVENTION

Many local code authorities require the use of backflow preventers so that in the event of a water system failure where household water pressure falls to zero, no water will flow out of the boiler system into potable water piping. Always use backflow prevention when using antifreeze in the boiler system. See FIG. 3.7 for proper location in the feed water inlet piping.

5.6.4. EXPANSION TANK

Water, like most other substances, expands when heated. As its volume increases, pressure increases. Since water can not be compressed, an air cushion is required in the system to absorb the increase in pressure, or the pressure relief valve will open. Adding a tank filled with air allows the pressure to compress the air and absorb the increase in pressure by allowing the volume of the water to increase.

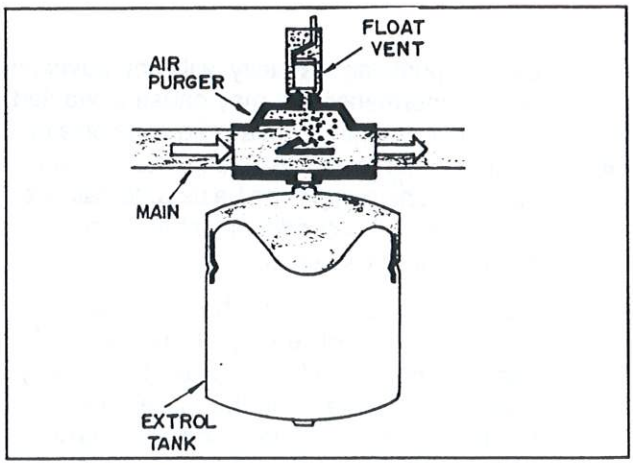


FIG. 5.6.4. *Diaphragm expansion tanks are more compact than air cushion tanks and will not become waterlogged.*

In older systems the tank was typically hung on the ceiling of the boiler room. The tank is pressurized as the system is filled and both water and air occupy the tank. This setup allows air to dissolve in the boiler water and the tank periodically must be drained and repressurized or the tank becomes waterlogged. Water eventually takes the place of a sufficient amount of the air to render the tank incapable of absorbing enough pressure to prevent the relief valve from leaking as the system water is heated.

Diaphragm tanks operate on the same principal, compressing air to allow system water to expand, but separate the air from the water with a rubber membrane. Diaphragm expansion tanks come pre-pressurized and are more compact will not become waterlogged.

Size the expansion tank according to the manufacturer's recommendations based on total water volume of the system or to the boiler's input. Systems containing a great deal of water such as cast iron standing radiation need larger expansion tanks than do systems of relatively low water volume such as copper finned baseboard.

Install the expansion tank in such a way that under no circumstances can the tank be isolated from the system. Do not install a shutoff valve ahead of the expansion tank.

5.6.5. PRESSURE RELIEF VALVE

Each GB series boiler is shipped with an appropriate pressure relief valve. All GB boilers are tested and approved under ASME (American Society of Mechanical Engineers) pressure testing procedures. GB boilers carry the National Board approval number which is stamped on the boiler heat exchanger's rating plate located directly on the boiler shell beneath the protective bulkhead and boiler insulation. ASME ratings permit the GB series boiler to be operated at pressures up to 100 psi.

Most residential systems are operated at from 12 to 20 psi and the relief valve shipped with the boiler is rated at 30 psi. Higher operating pressures will be needed in buildings in excess of three stories in height because of the weight of the vertical column of water in such systems and the pressure relief valve will have to be changed to a higher pressure valve, up to 100 psi provided that all other components of the system are A.S.M.E. rated as well.

The pressure relief valve must be installed so that under no circumstances can the valve be isolated from the boiler . See FIG. 3.7. Install no valve between the boiler and the pressure relief valve.

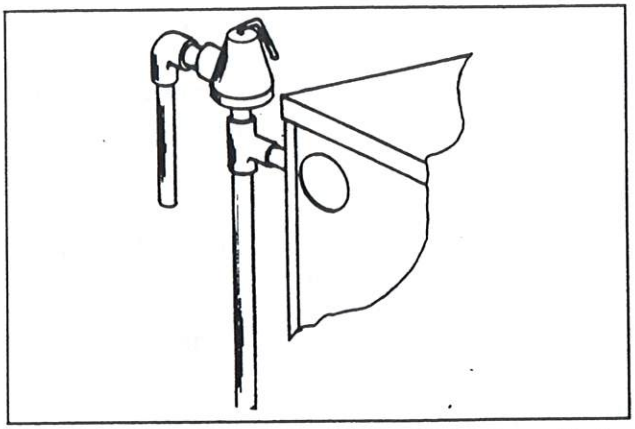


FIG. 5.6.5. *Install the pressure relief valve with the spindle in the vertical position as shown immediately after the boiler supply outlet.*

Always install the pressure relief valve with the spring loaded spindle in a vertical position and the discharge port in a horizontal position. Pipe the discharge port to within 18" of the floor to protect bystanders should the relief valve open.

5.6.6. ZONE CONTROL

Heating zones are controlled either with zone valves or zone pumps which are in turn controlled by room thermostats or aquastats. Since flow rate through the boiler is the critical design consideration, zone pumps are preferable in systems which have smaller piping or long runs of piping to the zones. See FIG. 3.8.4.

Zone valves may be used but the designer must specify a pump which will meet the required flow rate of the boiler when only the highest head zone (usually the longest zone) is calling for heat, and must allow for the head added to the system by the zone valve. See FIG. 3.11.3. A bypass system with a pressure differential overflow valve is recommended in all systems using two-way zone valves

Three-way zone valves are preferable to two-way zone valves because short bypass/balancing loops may be used which will allow the system to be adjusted for proper flow under all operating conditions. See FIG. 3.11.2.

Zoning arrangements which maintain boiler water temperature at a preset temperature are not recommended with the GB series boiler. Because of the GB boiler's low water content and low mass, severe short cycling would occur in such a system. Response time to a call for heat is almost instantaneous so no preheating of the boiler is needed.

5.6.7. ZONE PUMPS

Install a boiler pump to provide the required minimum flow through the boiler and bypass piping and install a zone pump sized to overcome the head of the zone only. The boiler and zone pump will work in series and assure proper flow rates for each zone and for the boiler. Zone pumps are installed in parallel but each one can act in series with the boiler pump.

The boiler pump selected can be sized to overcome the head of the domestic water heater, related piping, the diverter valve, and the boiler or water heating zones may be treated as individual, pumped zones.

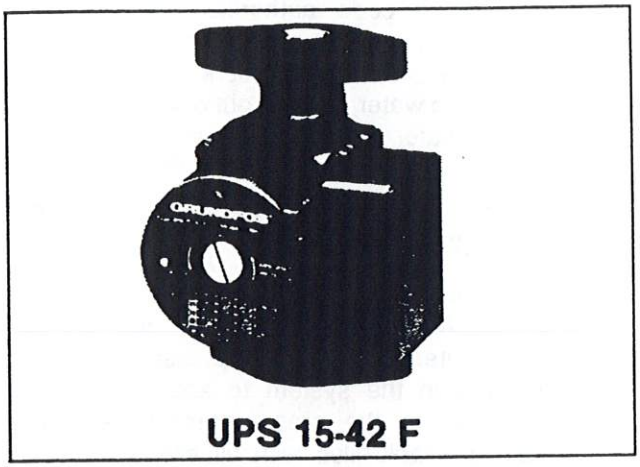


FIG. 5.6.7. *Multi-speed pumps allow system balancing electrically. Grundfos UPS 15-42 F pump is not adequate to pump the boiler by itself.*

Excess pumping capacity will not adversely affect boiler performance but may cause unwanted circulation of hot water through an idle zone on a call for heat from another zone. Isolating flange valves at the boiler or zone pumps can be used to balance systems experiencing this condition, or balancing cocks or flow controls may be installed.

Water velocities through the zones and through the boiler must be high enough to provide turbulent flow and good heat transfer but below the velocity at which noise can be created in the system piping, usually 8 feet per second. See the accompanying chart.

5.6.8. THREE-WAY ZONE VALVES

Zone control with three-way valves will allow idle zones to be bypassed and adequate flow through the boiler and individual zones can be achieved under all operating conditions. If, for example, each individual zone requires only three gallons per minute and the GB boiler requires eight gallons per minute, bypass piping around the idle zones can be set to pass five gallons per minute. Essentially, the bypass balancing valve is set to give the same amount of flow and head as the zone which is bypassed.

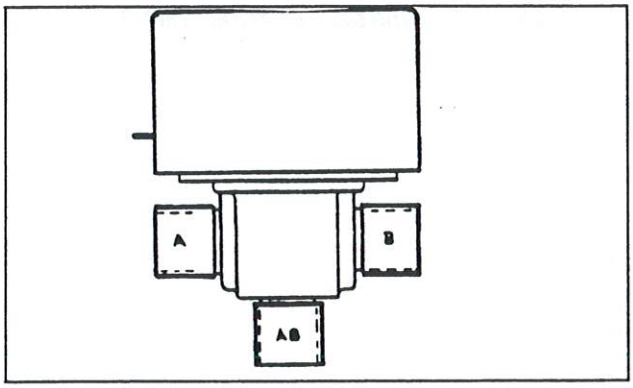


FIG. 5.6.8. *Diverter valves prioritize water heating zone or act as zone/bypass valve.*

5.6.9. TWO-WAY ZONE VALVES

If two-way zone valves must be used, bypass piping must be used to assure proper flow rate through the boiler. System pumping must be designed to overcome head through the boiler and through all zones, piping, and valves.

5.6.10. BYPASS PIPING

Bypass piping will assure that the system can be balanced to assure proper flow rates and temperature rise through the boiler and is recommended for all installations. See FIGS. 3.7., 3.8.4, 3.11.2, and 3.11.3.

5.7. FLUSH AND FILL SYSTEM

With any retrofit installation involving reuse of the existing radiation it is advisable to clean and flush the system before starting the new boiler. New systems may have loose particles of solder or flux in the piping and should be flushed also.

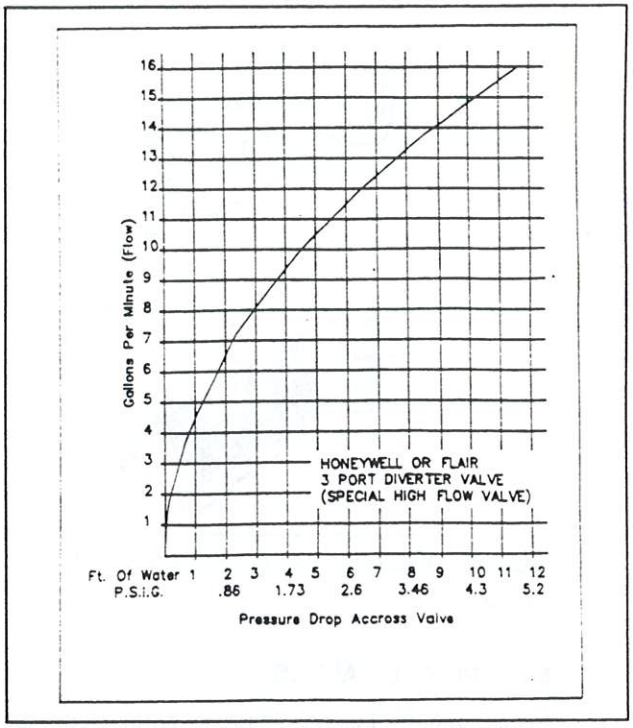


TABLE 12. *Friction loss in feet of head for Superior's two- and three-way high flow valves at various flow rates.*

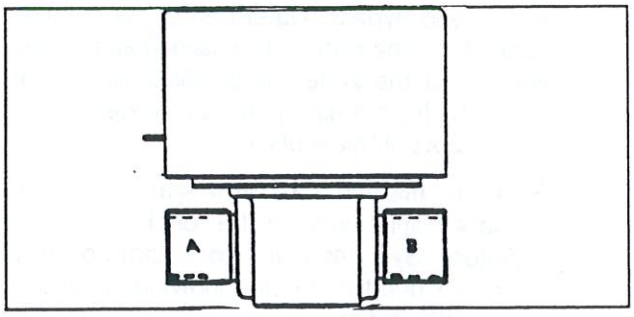


FIG. 5.6.9. *Two-way zone valves are the least preferred method of zoning because of their high friction loss and low flow problems possible.*

Sludge or debris in the system may affect heat transfer, pumping friction, or may cause pump failure.

Systems should be cleaned with a solution of trisodium phosphate (TSP) or boiler cleaner circulated through the system to dissolve any sludge in the system, then flushed with clean water. Addition of a y-type strainer just ahead of the circulating pump will trap any debris which is left in the system after flushing and will prevent that debris from entering the pump.

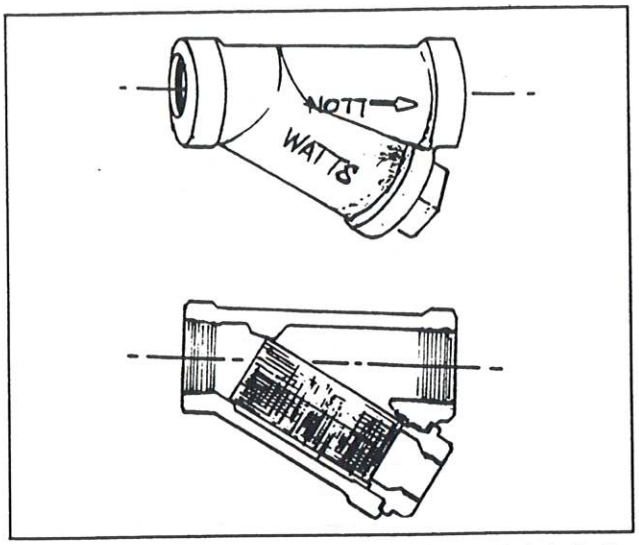


FIG. 5.7. *Y-Strainer will collect any loose debris in the piping.*

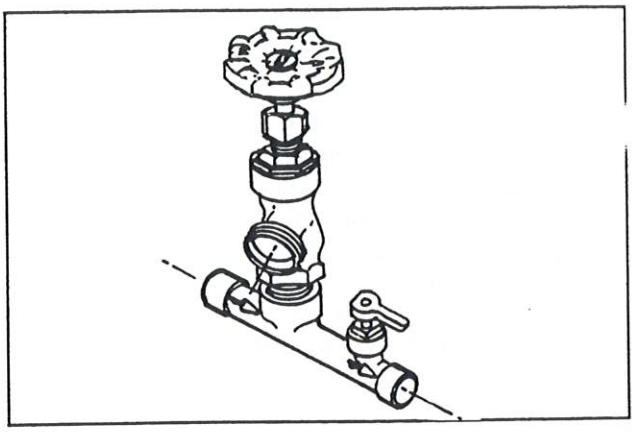


FIG. 5.7.1. *Purge and balancing valves are useful when filling and balancing the system.*

5.7.1. PURGE VALVES

Brass valves incorporating a zone balance/shutoff valve and a drain cock are available to make filling, balancing, and servicing of the system quicker and easier. By closing the balancing valve completely,opening the drain cock, and opening the boiler water feed bypass, water can be forced through the zone. Air in the zone will be carried along ahead of the water and the zone will be filled without having to bleed air from a high point. Let water run out of the drain cock until clear of air.

Systems utilizing cast iron standing radiation will probably still need to be bled at the individual radiators. Systems using convectors or air handlers may also need to be bled individually depending on their configuration.

6. START-UP AND CHECKOUT OF SYSTEM

After the installation is complete, the system has been flushed and filled with clean water, and the gas piping has been purged of air and tested for leaks with a solution of soapy water, a few simple steps to assure proper operation are recommended. With the boiler running clock the gas meter, (See SEC. 6.2.) or perform a CO_2 exhaust gas analysis (See SEC. 6.4.1) to determine that input is correct, check boiler temperature rise (See SEC. 6.4.4) to determine if pumping is maintained at the prescribed levels to insure quiet, efficient operation of the system, and run the boiler through several firing sequences to determine that ignition is proper.

Boilers converted to operate on LP gas must be checked for proper CO_2 readings to insure efficient, trouble-free operation. See SEC. 6.4.1.

6.1. FIRING THE BOILER

GB boilers are test fired on the production line and the input is set to proper levels using flow meters. If the boiler is supplied with the proper gas pressure, no adjustment should be necessary to achieve proper firing. Clock the meter (SEC. 6.2.) to be certain inputs are correct.

Complete the circuit from terminal R to W by turning up the room thermostat or by installing a jumper wire between R and W. Make sure the gas is turned on and 125 vac current is available to the boiler. The combustion air blower should start and the unit should begin its firing sequence. With the top of the boiler cabinet removed the flame may be observed through the sight glass in the burner mounting plate. The unit should fire and stay lit.

If the burner does not light immediately the ignition control may go into lockout. If this happens reset the control by interrupting power to the unit for 30 seconds, then retry. If the gas line has not been completely purged of air it may be necessary to make several tries until the burner stays lit.

If after several tries the burner does not light or will not stay lit, it may be necessary to adjust the gas pressure downstream from the gas valve by adjusting the gas valve's built-in pressure regulator. See SEC. 6.1.1.

If the burner still does not light after setting the gas pressures to the listed specifications increase the gas pressure by turning the regulator about one half turn clockwise, replace regulator cap, and retry. Repeat this process until the burner lights. Make sure that the igniter is glowing and that the gas valve is receiving 24 vac from the ignition module to open the valve during the ignition sequence.

If gas pressures are adjusted from the manufacturer's settings it is essential to perform a combustion gas CO_2 analysis after the burner lights to achieve proper CO_2 levels and avoid the production of excess carbon monoxide. See SEC. 6.4.1. for information on combustion analysis.

GAS INPUT LEVELS OVER OR UNDER THE MANUFACTURER'S RECOMMENDED SETTING WILL PRODUCE UNACCEPTABLE LEVELS OF CARBON MONOXIDE, A COLORLESS, ODORLESS GAS WHICH CAN BE FATAL IF BREATHED EVEN IN SMALL QUANTITIES.

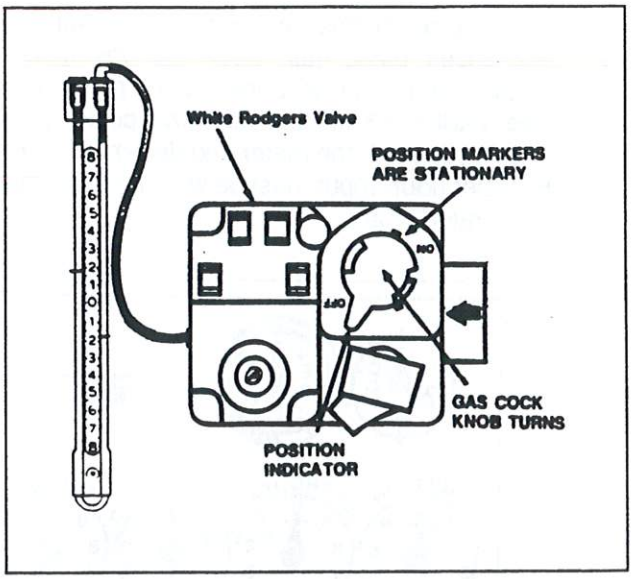


FIG. 6.1.1. *Checking gas pressures with a U-tube manometer gives a starting point from which to fine tune the burner.*

6.1.1. SETTING GAS PRESSURES

To check outlet gas pressure, remove the allen screw on the left side of the gas valve (the side toward the boiler's heat exchanger) and connect a U-tube manometer. Set the gas pressure to the proper setting for the gas being used: 2.5 " w.c. for natural gas and 8.5" w.c. for LP gas.

Setting gas pressure as above is always necessary when performing the LP gas conversion. See SEC. 6.3. for information on converting the boiler to use LP gas. To set outlet gas pressures, locate and remove the screw cap covering the gas valve's pressure regulator adjusting screw. Turn the plastic pressure regulator screw in (clockwise) to increase gas pressure, and out (counterclockwise) to decrease gas pressure. Replace the screw cap before reading pressures on the manometer.

Setting the gas pressures as above will give the proper coarse adjustment and a starting point from which to fine tune the burner. Fine tuning the burner requires the use of a combustion analyzer as described in SEC. 6.4.1.

6.2. CLOCKING THE GAS METER--NATURAL GAS

After the boiler has been started and with no other appliances using gas, clock the gas meter to be certain that the unit is running at the proper gas input. See TABLE 13 to determine the cubic feet of gas passing through the meter and determine the input in BTU per hour. Input must be within plus or minus 3% of the rated input.

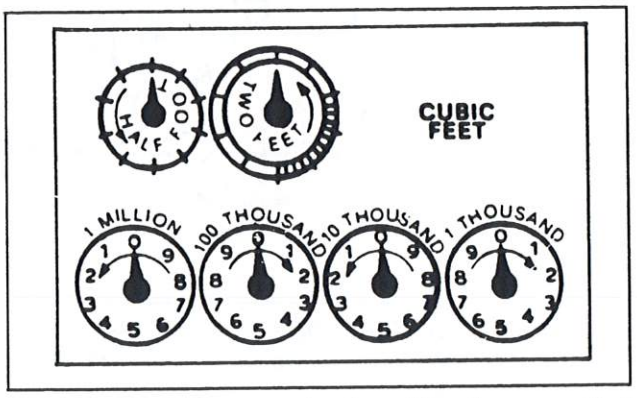


FIG. 6.2. *Typical gas meter face. Use the one or two foot dial to measure burner input.*

Turn off the gas supply to all other appliances except the boiler. With the boiler operating, time the one-, two-, or five-foot dial on the meter for one revolution. Time two revolutions if using a half foot dial. Use the appropriate column in TABLE 13 to determine the input to the burner. Adjust input at the gas valve regulator. Screw spring cap in (clockwise) to increase input, out (counterclockwise) to decrease input.

EXAMPLE: If the natural gas locally available contains 1,000 BTU per cubic foot and one revolution of the one cubic foot dial requires 40 seconds, then:

$$\frac{1{,}000 \text{ BTU/cu. ft. x } 3600 \text{ seconds per hour}}{40 \text{ seconds per cubic foot}} = 90{,}000 \text{ BTU per hour}$$

See TABLE 13 for a direct read out of the number of cubic feet per hour based on the number of seconds required for one revolution of various dial sizes. To convert to BTU multiply the number of cubic feet by the BTU value per cubic foot of natural gas locally available, usually 1,000 BTU per cubic foot. At higher altitudes natural gas is derated as a result of lower barometric pressures. Check with the local gas utility for the proper BTU value of the to use when determining input.

If the boiler is equipped with the original orifices input within the proper range will yield CO_2 readings within the range of 8.5 to 9% for natural gas. See SEC. 5.4.1 for information regarding flue gas analysis and CO_2 levels.

6.3. LP GAS CONVERSION

All GB boilers are built and shipped as natural gas fired units unless otherwise specified. Field conversion kits are available to convert GB series boilers to use LP gas.

CONVERSION TO LP GAS MUST ONLY BE PERFORMED BY QUALIFIED SERVICE PERSONNEL. THE PROCEDURE MUST INCLUDE COMBUSTION ANALYSIS FOR SAFE AND EFFICIENT OPERATION OF THE EQUIPMENT.

WARNING

6.3.1. LP GAS CONVERSION OF GB0907 ONLY

The discharge air orifice is not changed on any sea level conversion with the exception of the GB0907 (90,000 BTUH boiler. When converting the GB0907 disconnect the gas/air supply tube from the combustion air blower to the burner. Unscrew the nipple from the combustion air blower outlet, unscrew the black iron bell reducer from the nipple, and remove the aluminum orifice which is pressed into the end of the

SECONDS FOR ONE REVOLUTION	SIZE OF TEST DIAL		
	1 CU. FT.	2 CU. FT.	3 CU. FT.
10	360	720	1800
11	327	655	1636
12	300	600	1500
13	277	555	1385
14	257	515	1286
15	240	480	1200
16	225	450	1125
17	212	424	1059
18	200	400	1000
19	189	379	974
20	180	360	947
21	171	343	857
22	164	327	818
23	157	313	788
24	150	300	750
25	144	288	720
26	138	277	692
27	133	267	667
28	129	257	643
29	124	248	621
30	120	240	600
31	116	231	581
32	113	225	563
33	109	218	545

SECONDS FOR ONE REVOLUTION	SIZE OF TEST DIAL		
	1 CU. FT.	2 CU. FT.	3 CU. FT.
34	106	212	529
35	103	206	514
36	100	200	500
37	97	195	486
38	95	189	479
39	92	185	462
40	90	180	450
41	–	176	439
42	86	172	429
43	–	167	419
44	82	164	409
45	80	160	400
46	78	157	391
47	–	153	383
48	75	150	375
49	–	147	367
50	72	144	360
–	–	–	–
52	69	138	346
54	67	133	333
56	64	129	321
58	62	124	310
60	60	120	300
–	–	–	–

SECONDS FOR ONE REVOLUTION	SIZE OF TEST DIAL	
	2 CU. FT.	5 CU. FT.
62	116	290
64	112	281
66	109	273
68	106	265
70	103	257
72	100	250
74	97	243
76	95	237
78	92	231
80	90	225
82	88	220
84	86	214
86	84	209
88	82	205
90	80	200
92	78	196
94	–	192
96	75	188
98	–	184
100	72	180
102	–	176
104	69	173
106	–	170
108	67	167

TABLE 13. Number of cubic feet based on the number of seconds for one revolution on various test dials.

nipple by gently tapping the orifice out of the nipple. Use a wooden stick which will fit inside a 1-1/4" nipple to drive the orifice out of the pipe. Discard the existing discharge orifice and replace with the proper orifice bygently tapping the new orifice into the reamed end of the nipple or press the orifice in with a vise. Protect the new orifice from damage by using a wooden block when tapping or pressing the new orifice into place.

Reinstall the nipple with the discharge orifice in the top end of the nipple, the black iron bell reducer, and the compression fitting adapter. Reinstall the gas/air tube between the nipple and the burner. Be sure threads are gas-tight by checking the fittings with a soapy water solution while the combustion air blower is running. Proceed as described in SEC. 6.3.2.

6.3.2. LP GAS CONVERSION OF GB0607, GB13010, & GB16014

With the gas supply turned off, unscrew the ground joint union below the gas valve and remove the natural gas orifice located between the halves of the union and replace with the proper LP orifice for the unit. Discard unused orifices.

The discharge air orifice is not changed on any sea level conversion with the exception of the GB0907 (90,000 BTUH boiler. See SEC. 6.3.1. On all LP conversions proceed by removing the slotted aluminum screw cap covering the gas valve's pressure regulator and remove the plastic spring cap found behind the regulator cover. Remove the natural gas regulator spring and replace with the new spring contained in the LP conversion kit. Discard the natural gas spring. Replace the plastic spring cap and screw in approximately 1/4". This spring changes the range of pressures attainable with the pressure regulator to the range necessary for LP gas.

Check gas pressures with a U-tube manometer connected to the inlet side of the gas valve. Inlet pressures must be between 11.0 and 13.0" w.c. Check inlet pressures to the gas valve by removing the 1/8" pipe plug on the right (inlet) side of the gas valve and connecting the manometer to this port.

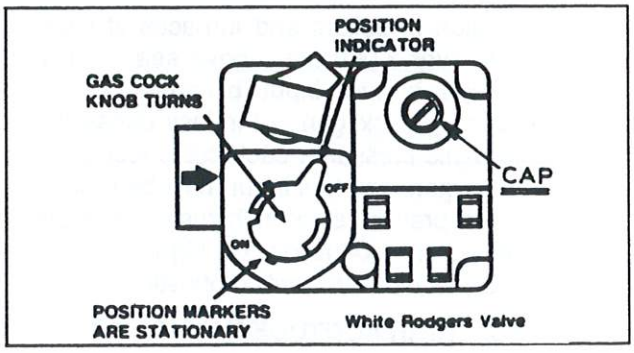


FIG. 6.3.2. *Gas valve showing location of pressure regulator adjusting cap.*

With the boiler running and the gas valve open check the gas valve outlet pressure with a manometer connected to the 1/8" port on the left (outlet) side of the gas valve. Set LP gas pressure downstream of the gas valve at 8.5" w.c. with the regulator cap in place (or cover the regulator port with a finger to take the reading). Pressure will differ depending on whether or not the cap is in place or the port is covered. Set the gas pressure about .5" w.c. higher with the port open to achieve the proper setting when the cap is reinstalled.

Turn the regulator spring cap clockwise to increase outlet pressure, counterclockwise to decrease outlet pressure.

Setting LP gas pressure to 8.5" w.c. will give a starting point for initial firing. If the unit does not immediately light and fuel lines are completely purged of air, set the gas pressure higher in steps of one-half turn of the pressure regulator spring cap screw until the burner ignites. Replace the gas valve's regulator cap after each adjustment before firing the burner. Remember to reset the ignition control if the unit goes into a lockout condition because of flame failure. See SEC. 7.4.8 and 7.4.9 for additional information regarding the ignition control.

Fine tune the burner by checking the CO_2 content of the exhaust gas with an appropriate combustion analyzer. See SECTION 6.4.1. CO_2 readings must fall between 9.7% and 10.7% for proper operation on LP gas. CO_2 testing is essential to the proper operation of the boiler on LP gas. Failure to set CO_2 levels will likely result in delayed ignition and/or failure to light resulting in call backs for the installer.

6.3.3. HIGH ALTITUDE CONVERSION

Operation of boilers and furnaces at high altitudes, that is over 3,000 feet above sea level, requires a reduction in fuel input because of the reduced availability of oxygen in the less dense air. At lower barometric pressures each cubic foot of air contains less oxygen, and fuel input must be reduced accordingly to prevent a too-rich fuel-air mixture and the subsequent production of high levels of carbon monoxide and inefficient combustion.

6.3.3.1. HIGH ALTITUDE NATURAL GAS UNITS

Most natural gas companies will provide the BTU value of their gas at the average altitude for their operating area and should be consulted to determine how best to proceed in adjusting for high altitude operation in their operating area. In most cases the installer will find that the BTU value of the gas at a given altitude is proportionally less than natural gas at sea level. That proportion will usually correspond to the required decrease in burner input of 4% per 1,000 feet above sea level as prescribed in the National Fuel Gas Code and AGA regulations.

The final answer as to the proper operation of the unit will always be obtained through combustion analysis: if carbon dioxide and carbon monoxide levels are within the appropriate ranges, the unit is firing satisfactorily. If the BTU value of the gas provided by the local utility is intentionally increased then, and only then, will a decrease in orifice size be required when installing a natural gas unit at high altitudes.

DO NOT ATTEMPT TO SET UP A BURNER FOR HIGH ALTITUDE OPERATION UNLESS YOU POSSESS THE PROPER SKILLS AND EQUIPMENT TO DO COMBUSTION ANALYSIS.

WARNING

When installing GlowCore furnaces and boilers at high altitude, attempt to fire the unit with the factory installed orifices called for in the following table for sea level operation. Gas-air ratios will probably be correct for optimum combustion with the sea level natural gas orifices as factory equipped under normal circumstances where natural gas BTU values are proportionally less.

Air and discharge orifices will not be changed. The table gives the proper combustion air pressure switch to use at various altitudes. These switches will have to be changed to obtain proper safety control relative to the combustion air flow.

If the unit does not immediately fire with the sea level orifices after fuel lines have been purged of air, and firing cannot be obtained by adjusting the gas pressure regulator in the gas valve it will be necessary to change the gas orifice, probably to the next smaller, or in some cases the next larger orifice.

When the unit fires, perform a carbon dioxide combustion gas analysis and set the CO_2 level to 8.5 to 9.0% for a natural gas fired unit. Increase gas pressure to increase CO_2 and decrease gas pressure to decrease CO_2. Be sure that an increase in pressure, obtained by turning the gas pressure regulator screw clockwise, increases CO_2 or that a decrease in pressure, obtained by turning the gas pressure regulating screw out or counterclockwise, produces a decrease in CO_2 levels. If the CO_2 levels

respond in this way, the unit is firing properly. Note that if the unit is grossly over-fired for the amount of oxygen available the same CO_2 readings may be achieved, but changes in gas pressure will have the opposite effect on the CO_2 level: increases in gas pressure will produce a decrease in CO_2. The sea level orifices will produce firing rates close to the optimum rate.

Following the above procedure will lead to combustion which is at a lesser BTU per hour input than at sea level to compensate for the reduced oxygen availability at high altitude. *The unit will operate at a reduced input although the gas meter will likely indicate the same amount of cubic feet per hour of gas as at sea level.* Since the same volume of gas at high altitude will contain less BTUs, the firing rate will be decreased. The final input in BTUs will be less than sea level input by about 4% per thousand feet above sea level.

In most cases no change will be needed to operate GlowCore boilers and furnaces on natural gas at high altitudes. Only combustion testing and a slight adjustment of the gas valve pressure regulator may be necessary. Orifice change, if necessary, will be indicated by combustion testing and an inability to achieve proper CO_2 levels and will usually require a change of only one orifice size smaller or larger. Choose an orifice which will allow the gas pressure regulator screw to be set at about the middle of its travel, that is with an outlet gas pressure of 2.5" to 2.7" w.c. for natural gas, while permitting proper adjustment of the CO_2 level.

EXAMPLE FOR NATURAL GAS: *Upon installation of a GlowCore unit at high altitude on natural gas of unknown BTU value, attempt to fire the unit with the orifices provided in the unit. If the unit fires, check and adjust CO_2 until the proper level (8.5-9.0% CO_2) is achieved.*

If the unit will not fire, change to the next smaller orifice and attempt to fire again. If the unit still will not fire, try the next larger orifice. If the unit will not fire with any of these three orifices contact the local gas company for the BTU value of the gas, then check with your GlowCore distributor or the GlowCore service department for the proper orifice to use based on the gas BTU value. When the unit fires, perform a combustion analysis as above and adjust to proper CO_2 level.

Carbon monoxide levels will be acceptable (below 400 parts per million) if an increase in gas pressure produces an increase in carbon dioxide (CO_2) levels, or a decrease in gas pressure produces a decrease in CO_2 levels.

6.3.3.2. HIGH ALTITUDE LP GAS UNITS

LP gas has a consistent BTU value even at high altitudes because it is much denser than natural gas and because it is delivered as a liquid to the end user's site. On units to be fired with LP gas at high altitude, replace the factory installed orifice with the orifice called for in the chart for the given altitude and proceed to fire the unit as above. Assure proper combustion by performing CO_2 analysis as described above. CO_2 levels for LP fired units must fall between 9.7 and 10.7%.

EXAMPLE FOR PROPANE GAS: *Install the propane conversion kit as directed in the kit's instructions. Change the gas orifice as indicated in the chart for the given altitude, the gas valve pressure regulator spring, and the combustion air pressure switch, and attempt to fire the unit. If the unit fires, check and adjust CO_2 to between 9.7% and 10.7%.*

If the unit will not fire after purging the gas line and adjusting gas pressure, change to the next smaller orifice and retry. If the unit still does not fire, install the next larger orifice and try again.

Carbon monoxide levels will be acceptable if an increase in gas pressure produces an increase in carbon dioxide (CO_2) levels, or a decrease in gas pressure produces a decrease in CO_2 levels. If CO_2 levels decrease with and increase in gas pressure or if CO_2 levels increase with a decrease in gas pressure, the unit is too fuel rich and grossly overfired and a reduction in orifice size is mandatory to correct this situation.

The installation is complete when the unit fires at the proper CO_2 level for propane (9.7-10.7% CO_2) and adjustment of the gas pressure produces results as described above.

Orifices are changed as described in SEC.S 6.3.1 and 6.3.2, LP gas conversions. Since the operating air pressures also change, the combustion air switch (SEC. 7.3.6.) must also be changed.

6.4. FLUE GAS ANALYSIS FOR OPTIMUM OPERATION

Flue gas analysis will provide precise information regarding the operation of the GB series boiler. All units must be checked for proper fuel/air mixture and annual tune-up of the boiler will be appreciably more reliable if combustion analysis is performed after cleaning the burner.

6.4.1. CHECKING CO_2 LEVELS

Carbon dioxide is a colorless, odorless gas produced by all combustion processes. When the GB series boiler is operating properly CO_2 levels will be between 8.5 and 9.0% CO_2 for natural gas and between 9.7 and 10.7% CO_2 for LP gas. To measure CO_2 levels in the GB series boiler drill a 1/4" hole (or the appropriate size hole for the test probe) in the exhaust piping near the boiler's exhaust outlet. Insert the probe in the exhaust pipe and sample the gases as instructed in the test equipment's instructions. See FIG. 6.4.1.

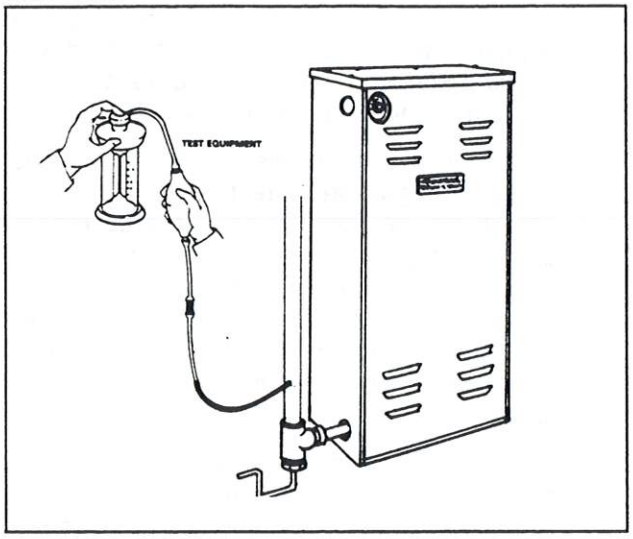


FIG. 6.4.1. *Testing for CO_2 or CO levels in flue gases.*

To raise CO_2 levels increase the gas input by turning the plastic screw under the regulator cap clockwise. Lower CO_2 levels by screwing the regulator adjusting screw counterclockwise.

If CO_2 levels do not respond to adjustments as listed above the burner is probably grossly overfired. If, for instance, a clockwise adjustment to the gas regulator produces a decrease in CO_2 the burner is too fuel-rich and not enough oxygen is present for proper and complete combustion.

FIG. 6.4.2 shows the relationship of CO_2 and CO production to the fuel/air mixture. Note that the same CO_2 reading can be achieved on either side of the theoretically ideal combustion known as *stoichiometric combustion.*

An overfired condition may yield proper CO_2 levels. However, carbon monoxide (CO) levels above .04% (400 parts per million) will be present if overfired or if combustion air intake is partially blocked. Carbon monoxide is a colorless, odorless gas which can be fatal if breathed in even small quantities. Sample exhaust gas for CO in the same way as CO_2 using the proper test instrument for CO.

Seal the hole in the vent pipe used for sampling with high temperature RTV silicone sealant after completing the test.

SEAL THE VENT PIPE TEST PORT AFTER PERFORMING COMBUSTION ANALYSIS. EXHAUST GASES MUST NOT BE ALLOWED TO CONTAMINATE THE INDOOR AIR OF A STRUCTURE.

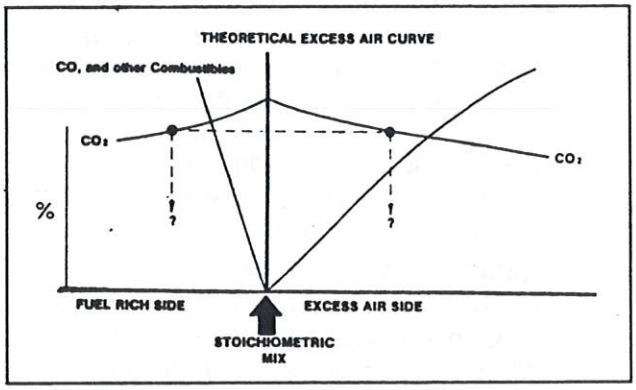


FIG. 6.4.2. *Carbon dioxide readings alone do not determine proper fuel/air mixture.*

6.4.2. CHECKING CARBON MONOXIDE LEVELS IN FLUE GAS

Checking for carbon monoxide (CO) is also useful in setting proper combustion. CO_2 readings of 8.5-9% for natural gas and 9.7-10.7% for LP gas will be associated with acceptable CO levels of less than 200 parts per million (.02%) when on the excess air side, and unacceptable levels over 200 parts per million (.02%) or over when on the fuel rich side. Most gas companies will accept operation at up to 400 parts per million.

6.4.3. CHECKING TEMPERATURE RISE THROUGH THE BOILER

Temperature rise through the boiler will vary according to input or pumping rates. At a given input proper pumping rates (1 GPM per 10,000 BTU output) will produce a temperature rise (difference in temperature between supply and return water) of 20°F or less. If temperature rise exceeds 20°F, noisy operation of the unit may occur because water in the boiler flashes to steam. This condition may occur even though outlet water temperatures are below 212°F.

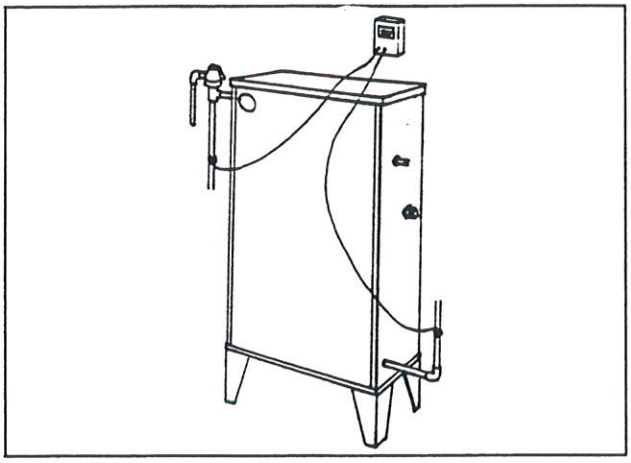


FIG. 6.4.3. *Checking boiler temperature rise to assure proper pumping rates.*

To insure that the proper pump has been installed and the system is working properly, take simultaneous readings of both the supply and return water temperatures with the boiler fired. See FIG. 6.4.3. The difference between these two readings is the temperature rise through the boiler and should be 20°F or less. If a temperature difference of greater than 20°F is found, a higher head pump may be needed. Reducing the input will also decrease temperature differentials.

6.5. BALANCING FLOWS

Multiple zone systems should be balanced to assure adequate heat delivery to each zone. Installation of balancing cocks in each zone will facilitate system balancing. When all zones are calling for heat and flow rates are proper the system will show equal temperature drops through each zone between supply and return piping. If designed properly the system should produce temperature drops of about 20°F.

6.6. SETTING THERMOSTAT HEATING ANTICIPATOR

Thermostats usually contain heat anticipators to deal with the operating differential of the system to be controlled. The heat anticipator is a resistance heater located near the bimetal element in the thermostat which heats when the thermostat contacts close. The heat from the anticipator coil raises the temperature of the bimetal element faster than the surrounding air, causing the thermostat to shut off the heating system faster than would air temperature alone.

This anticipation prevents objectionable heating overrun and keeps room temperatures closer to the set point. Low voltage thermostats have adjustable anticipators to match the exact current draw of the heating system. The GB boiler's heat anticipator should be set at approximately 1.0 amp for proper operation. The optimum setting can best be achieved by measuring the actual draw of the circuit as shown and setting the anticipator accordingly. Control wiring lengths and variables within the relay coil will cause some differences to the approximate rating of 1.0 amp.

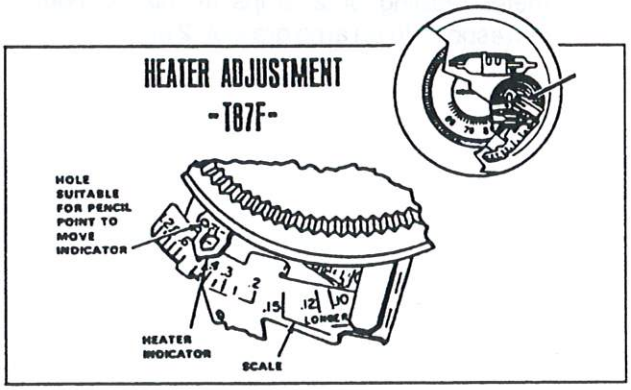


FIG. 6.6. *Set heat anticipator to 1.0 amps or read the amp draw of zone valves and relays and set anticipator accordingly.*

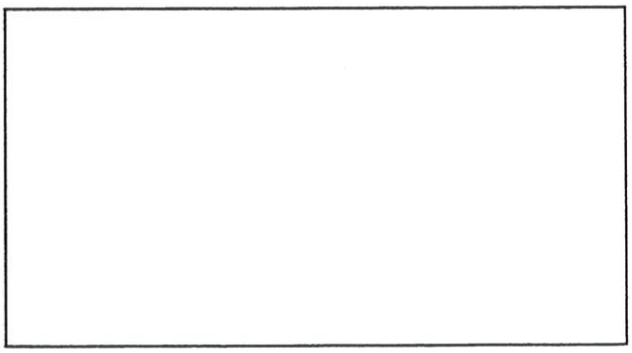


FIG. 6.6.1. *Reading thermostat circuit amp draw in order to set thermostat anticipator.*

Many electronic thermostats use a different type of anticipator to perform the same function. Check the thermostat manufacturer's recommendation for setting the anticipator on electronic thermostats. Programmable electronic thermostats may also require the use of isolation relays. Check the thermostat manufacturer's recommendations.

6.6.1. ANTICIPATOR SETTING

Anticipator settings depend on the circuit to which the thermostat is connected. The boiler relay will give a 1.0 amp draw if the thermostat is connected directly to the boiler's R and W terminals. If the thermostat controls zone valves or pump relays take an amp draw reading and set the anticipator accordingly.

Turn off power to the system and remove the thermostat from the subbase or wall plate. Wrap exactly 10 turns of wire around the jaws of a split jaw induction type current meter. See FIG. 6.6.1. Connect one end of the wire to R and the other to W. Restore power to the boiler and allow the system to run for approximately one minute. Read the amp scale and divide the reading by 10 to obtain the current draw. A meter reading of 2 amps in this configuration will correspond to an amp draw of .2 amp.

7. SEQUENCE OF OPERATION

GB series boilers prior to serial number 895300000 include direct spark ignition systems to light the main burner. Boilers produced after serial number 895300000 include hot surface ignition (HSI) systems. Both systems light the burner directly and have no pilot flame. All safety devices in the boiler operate on low voltage (24 vac). Direct spark units may be converted to hot surface ignition if desired.

7.1. DIRECT SPARK IGNITION

NORMAL START

1. Thermostat calls for heat making the circuit between R and W terminals on the circuit board located on top of the 24v transformer.

2. Combustion air blower relay R_1 is energized closing line voltage contacts in R_1 starting the combustion air blower. Note: Double pole relay installed in GB boilers may be used to simultaneously start the boiler circulating pump.

3. Proper pressure or pressure differential is established thereby closing the combustion air pressure switch contacts and energizing the flame safety control through the unit's safety and temperature controls.

4. With the flame safety control energized the ignitor begins sparking and the main gas valve opens and the burner ignites.

5. If flame is proven through the flame sensor rod the main gas valve will remain open and burner will continue to run.

6. Water in the boiler is heated and delivered to the heat distribution system.

NORMAL SHUTDOWN

1. When the thermostat is satisfied, the thermostat contacts open and the circuit from R to W is broken.

2. The main gas valve is de-energized and closes interrupting the flow of gas and extinguishing the burner.

3. The combustion air blower relay R_1 is de-energized interrupting power to the combustion air blower and the circulating pump (if wired into the R_1 relay).

7.2. HOT SURFACE IGNITION

NORMAL START

1. Thermostat calls for heat making the circuit between R and W terminals on the circuit board located on top of the 24v transformer. If a relight timer is used a one minute delay between the call for heat from the thermostat and the beginning of the ignition sequence will occur.

2. Combustion air blower relay R_1 is energized closing line voltage contacts in R_1 starting the combustion air blower. Note: Double pole relay installed in GB boilers may be used to simultaneously start the boiler circulating pump.

3. Proper pressure or pressure differential is established thereby closing the combustion air pressure switch contacts and energizing the flame safety control through the unit's safety and temperature controls.

4. With 24 volt power supplied through the safety control circuits to the hot surface ignition control the ignition control supplies 115 volts to the hot surface igniter. Approximately 35 to 45 seconds is allowed to prepurge the combustion chamber and bring the igniter up to temperature.

5. 24 volts is supplied to the gas valve and the gas valve opens after preheat.

6. Hot surface igniter is de-energized and switches to flame sensing mode.

7. Gas valve remains open and burner remains on until thermostat is satisfied. Sequence is identical for water heating mode.

ABNORMAL SEQUENCE

1. If the hot surface igniter fails to light the burner within ten seconds the gas valve will close and the ignition cycle will begin again.

2. If the burner fails to ignite on the third try the control will lock out and remain locked out until power is interrupted for thirty seconds to reset the control.

NORMAL SHUTDOWN

1. When the thermostat is satisfied the 24 volt circuit will be broken, the R_1 relay will be de-energized stopping the combustion air blower, and the gas valve will close.

2. If a relight timer is used the 24 volt circuit will be

interrupted after thirty minutes of continuous run time and the ignition control will be reset. If the unit has been in lockout, another series of tries for ignition will be started.

7.3. BOILER CONTROLS AND SAFETY DEVICES

GB series boilers include low voltage safety controls to prevent firing in the event of intake or exhaust blockage, temperature activated controls to prevent overheating of heat transfer solution and exhaust gas, and to insure that the boiler is filled with water and under pressure to prevent dry-firing.

7.3.1. LOW VOLTAGE TERMINAL BLOCK

The GB boiler uses the terminal strip mounted on the low voltage transformer to provided wiring facilities for the low voltage controls. R and W terminals are used for room thermostat and water heater aquastat hook up.

The R and W terminals are powered by the 24 volt transformer and may be used to power most types of thermostats. However, if zone valves or pump relays are to be used, an isolating relay and separate power source will be required to prevent overloading of the 40va transformer and to prevent transformers from working against each other resulting in transformer failure.

7.3.2. TEMPERATURE LIMIT CONTROL

The temperature limit control is an adjustable, temperature actuated single-pole, single-throw, normally closed switch which governs the normal maximum water supply temperature to the heat distribution system. The temperature limit control is mounted on a metal plate brazed to the boiler outlet pipe next to the auxiliary limit control. The accompanying chart indicates the part number and ratings of the control on each model of GB boiler.

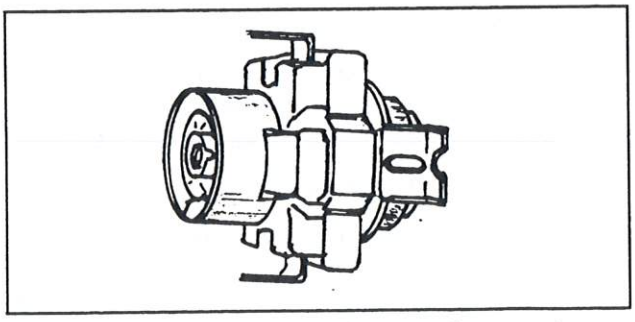


FIG. 7.3.2. *Temperature limit control opens in response to high boiler water temperature.*

The operating control has a fixed differential of 15°F. If the control opens on high temperature, boiler water temperature will have to fall 15°F before the circuit is reclosed and the unit refires. During the time the control is open the R_1 relay will remain energized and the combustion air blower and circulating pump (if controlled by R_1) will continue to run because of the brown wire running from the temperature limit control to the "G" terminal on the transformer terminal board which will keep the relay coil energized.

Normal operation of this control with typical hot water convectors will require setting the limit to its highest "E" setting.

7.3.3. AUXILIARY LIMIT CONTROL

The auxiliary limit control is mounted on the same plate on the boiler outlet piping as the temperature limit control and acts as a backup to shut the burner down should the temperature limit fail in the closed position. Like the temperature limit control, the auxiliary limit is temperature activated.

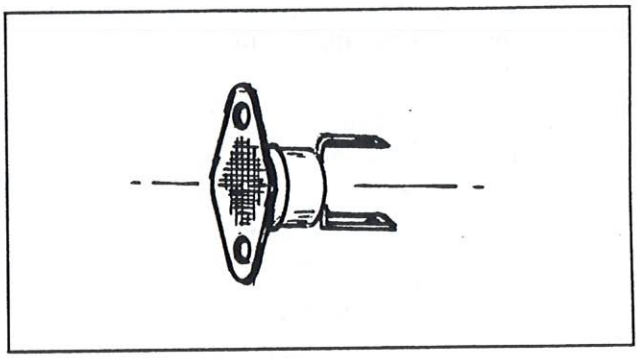


FIG. 7.3.3. *The auxiliary limit control serves as redundant backup to the temperature limit control.*

Temperature differential for the auxiliary limit control is fixed at 15°F. which means that boiler water will have to cool at least that amount before the unit will refire. The combustion air blower and the circulating pump will continue to run with the auxiliary limit open on high temperature but the gas valve will be de-energized and will extinguish the burner. See the accompanying chart for part numbers and temperature ratings of the auxiliary limit for the various boiler models.

7.3.4. EXCESS TEMPERATURE SWITCH

The excess temperature switch is designed to sense exhaust gas temperature and to open at about 225°F. Because of a thermal lag between the temperature at the switch and the internal flue gas temperature, flue gas temperatures can be somewhat higher than the switch setting would indicate. Flue gas temperatures in the GB series boilers rarely exceed 250°F. Temperatures over 250°F indicate loss of proper water flow through the boiler, obstruction within the heat exchanger limiting the flow of heat through the exchanger to the boiler water, a problem with the restrictor, or an overfired condition.

The excess temperature limit on GB series boilers will automatically reset as temperatures within the exhaust piping drop by about 30°F.

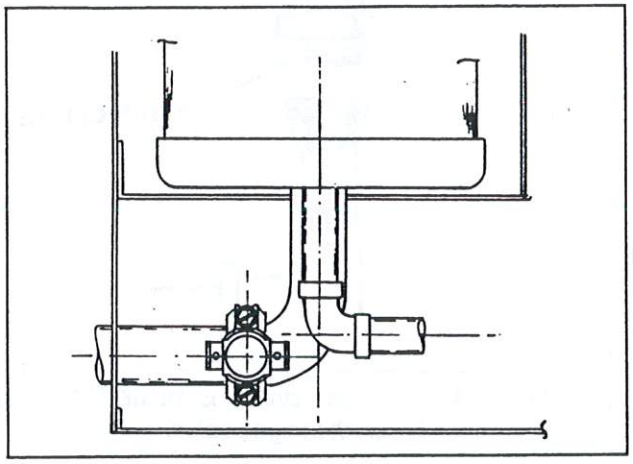


FIG. 7.3.4. *The excess temperature limit mounts on the boiler's exhaust outlet to sense abnormally high exhaust temperatures.*

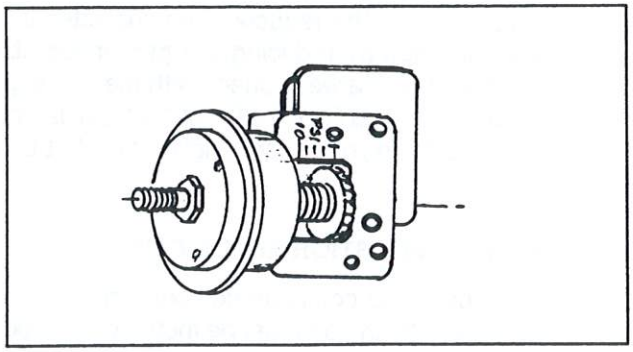


FIG. 7.3.5. *The water pressure switch assures that the boiler has adequate water pressure to avoid dry-firing.*

7.3.5. WATER PRESSURE SWITCH

The water pressure switch is a diaphragm-actuated micro switch which proves that the boiler has been charged with water to avoid dry-firing. If the switch is not closed 24 vac power will not be delivered to the R_1 relay to start the combustion air blower and the boiler can not start. The water pressure switch is connected to a tee in the boiler water outlet piping just above the boiler shell.

7.3.6. COMBUSTION AIR PRESSURE SWITCH

The combustion air pressure switch is a safety device which will prevent the boiler from firing in the event of blockage of the intake or exhaust pipe, burner or filter. The pressure switch, mounted on the right side of the boiler's cabinet, senses pressures on either side of the intake air orifice through the two tubes connected to the intake piping. The switch contains a diaphragm which responds to air pressures in the proper range of differential across the intake orifice.

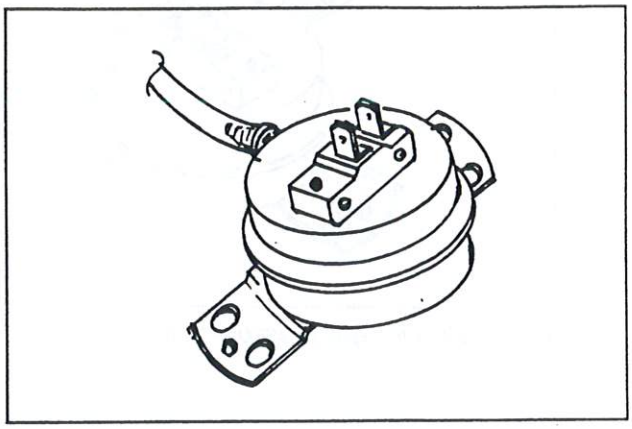


FIG. 7.3.6. *The combustion air pressure switch will not allow the burner to fire with an obstructed vent or intake.*

Air moving through an orifice experiences a pressure drop from one side of the orifice to the other. Suction (negative) pressures are greater on the side toward the combustion air blower's intake than ahead of the orifice. Any obstruction in either the intake or exhaust will slow air flow and decrease the pressure differential. The combustion air pressure switch senses the difference in pressure and will open should the differential fall below the established limits and shut off the flow of gas to the burner.

7.3.7. FLUE GAS PRESSURE SWITCH

A second diaphragm-type air pressure switch is connected to a tapping in the burner mounting plate by 1/4" aluminum tubing. This flue gas pressure switch is normally closed and reacts to an increase in pressure within the combustion chamber above 6" w.c. An increase in pressure indicates exhaust blockage. The flue gas pressure switch will safely shut the unit down and prevent pressure within the exhaust piping from blowing the water out of the condensate trap and allowing byproducts of combustion from contaminating indoor air.

The flue gas pressure switch is in series with the other safety controls in the low voltage safety circuit wiring and will interrupt power to the gas valve.

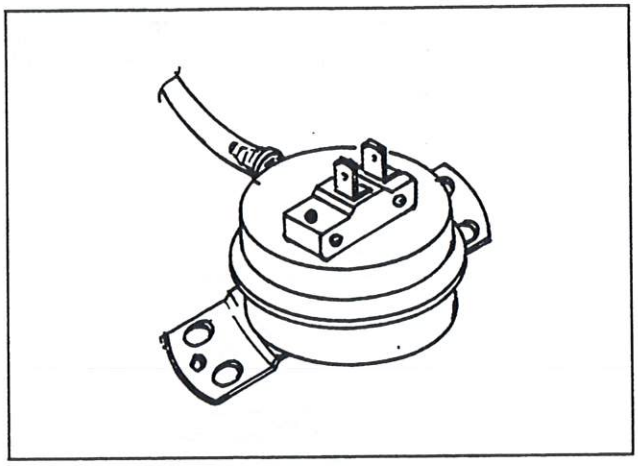


FIG. 7.3.7. *Flue gas pressure switch.*

7.4. DESCRIPTION OF PARTS

By understanding the operation of the individual controls and parts and the way they react and interact, service and troubleshooting are made easier.

7.4.1. ORIFICES

Three metering orifices govern the combustion process and provide the proper gas/air mixture to the burner: the gas orifice, the combustion air orifice, and the discharge orifice.

7.4.2. GAS ORIFICE

The dish-shaped aluminum gas orifice is located in the iron pipe union just below and downstream from the gas valve. The difference in pressure on either side of the orifice causes the metered flow of gas through the orifice.

The precise size of that orifice dictates the firing rate of the burner. Changes within a range dictated by the orifice can be affected by adjusting the pressure of the gas upstream of the orifice with the gas valve's pressure regulator. Because of the difference in BTU value of natural and LP gases, different orifices are required for each gas to provide the specified input. See TABLE 14 for a listing of all orifices used in the GB series boilers.

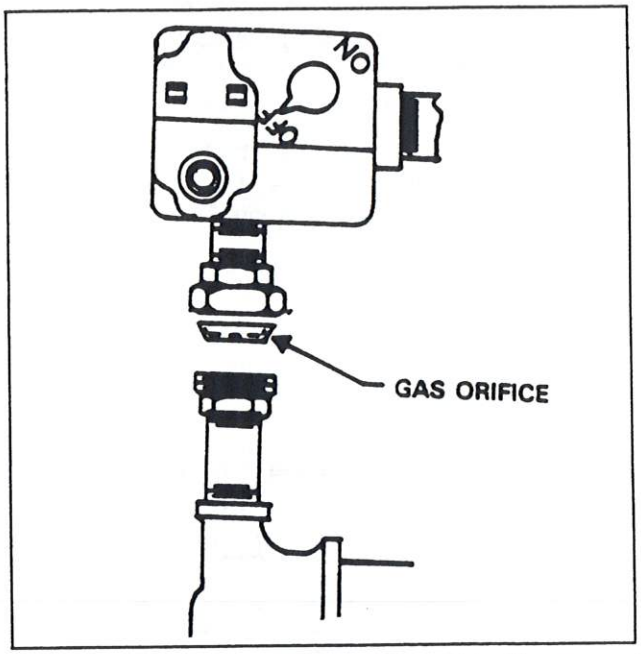


FIG. 7.4.2. *The gas orifice is located in the ground joint union beneath the gas valve.*

7.4.3. HIGH ALTITUDE GAS ORIFICES

The firing rate is reduced at higher altitudes (above 3,000 ft. mean sea level) to compensate for the lower density of air. The reduction of firing rates is usually accomplished by reducing the gas orifice size. The installer should always check with the fuel supplier to determine the BTU content of fuel available locally and adjust firing rate accordingly. See TABLE 14.

7.4.4. COMBUSTION AIR ORIFICE

For proper and complete combustion at the metered gas flow rate, the air must be metered in proportion to the flow of gas. The pressure differential developed by the combustion air blower causes air to flow through the combustion air orifice at a known rate based on air density, differential pressure, and the size of the orifice. See TABLE 14.

MODEL NO.	ALT	GAS ORIFICE SIZE/PART NUMBER NAT	GAS ORIFICE SIZE/PART NUMBER LP	AIR PRESS. SWITCH SETTTING/PART NO. NAT	AIR PRESS. SWITCH SETTTING/PART NO. LP	SUCTION AIR ORIFICE SIZE/PART NO. NAT	SUCTION AIR ORIFICE SIZE/PART NO. LP	DISCHARGE AIR ORIFICE SIZE/PART NO. NAT	DISCHARGE AIR ORIFICE SIZE/PART NO. LP
GB040	SEA LEVEL	#38 2500027	#51 2500057	4.0"W.C. 2100015	4.0"W.C. 2100015	.437 2500001	.406 2500006	.375 2500000	.375 2500000
	3000'	#38 2500027	#51 2500057	4.0"W.C. 2100015	4.0"W.C. 2100015	.437 2500001	.406 2500006	.375 2500000	.375 2500000
	4000'	#38 2500027	#51 2500057	4.0"W.C. 2100015	4.0"W.C. 2100015	.437 2500001	.406 2500006	.375 2500000	.375 2500000
MODEL NO.									
GB060	SEA LEVEL	#30 2500056	#43 2500026	4.0"W.C 2100015	4.0"W.C. 2100015	.500 2500003	.500 2500003	.437 2500001	.437 2500001
	3000'	#30 2500056	#43 2500040	2.0"W.C. 2100006	2.0"W.C. 2100006	.500 2500003	.500 2500003	.437 2500001	.437 2500001
	4000'	#30 2500056	#45 2500040	2.0"W.C. 2100006	2.0"W.C. 2100006	.500 2500003	.500 2500003	.437 2500001	.437 2500001
	5000'	#30 2500056	#47 2500039	2.0"W.C. 2100006	2.0"W.C. 2100006	.500 2500003	.500 2500003	.437 2500001	.437 2500001
	6000'	#30 2500056	#47 2500039	2.0"W.C. 2100006	2.0"W.C. 2100006	.500 2500003	.500 2500003	.437 2500001	.437 2500001
	7000'	#30 2500056	#49 2500041	2.0"W.C. 2100006	2.0"W.C. 2100006	.500 2500003	.500 2500003	.437 2500001	.437 2500001
	8000'	#30 2500056	#49 2500041	2.0"W.C. 2100006	2.0"W.C. 2100006	.500 2500003	.500 2500003	.437 2500001	.437 2500001
	9000'	#30 2500056	#49 2500041	2.0"W.C. 2100006	2.0"W.C. 2100006	.500 2500003	.500 2500003	.437 2500001	.437 2500001
	10,000'	#31 2500054	#50 2500058	2.0"W.C. 2100006	2.0"W.C. 2100006	.500 2500003	.500 2500003	.437 2500001	.437 2500001
	11,000'	#31 2500054	#50 2500058	2.0"W.C. 2100006	2.0"W.C. 2100006	.500 2500003	.500 2500003	.437 2500001	.437 2500001

TABLE 14. *Combustion air pressure switches, natural and LP gas orifices, combustion air orifices, discharge orifices and the resultant input for GB series boilers at various altitudes above sea level.*

MODEL NO. GB090	GAS ORIFICE SIZE/PART NUMBER			AIR PRESS. SWITCH SETTTING/PART NO.		SUCTION AIR ORIFICE SIZE'PART NO.		DISCHARGE AIR ORIFICE SIZE/PART NO.	
	ALT	NAT	LP	NAT	LP	NAT	LP	NAT	LP
	SEA LEVEL	#9 2500053	#30 2500056	1.1"W.C. 2100014	1.1"W.C. 2100014	.875 2500002	.875 2500002	.562 2500004	.500 2500003
	3000'	#9 2500053	#31 2500054	.85"W.C. 2100017	.85"W.C. 2100017	.875 2500002	.875 2500002	.562 2500004	.500 2500003
	4000'	#9 2500053	#31 2500054	.85"W.C. 2100017	.85"W.C. 2100017	.875 2500002	.875 2500002	.562 2500004	.500 2500003
	5000'	#9 2500053	#32 2500035	.85"W.C. 2100017	.85"W.C. 2100017	.875 2500002	.875 2500002	.562 2500004	.500 2500003
	6000'	#9 2500053	#33 2500036	.85"W.C. 2100017	.85"W.C. 2100017	.875 2500002	.875 2500002	.562 2500004	.500 2500003
	7000'	#9 2500053	#34 2500037	.85"W.C. 2100017	.85"W.C. 2100017	.875 2500002	.875 2500002	.562 2500004	.500 2500003
	8000'	#9 2500053	#36 2500050	.85"W.C. 2100017	.85"W.C. 2100017	.875 2500002	.875 2500002	.562 2500004	.500 2500003
	9000'	#9 2500053	#38 2500027	.85"W.C. 2100017	.85"W.C. 2100017	.875 2500002	.875 2500002	.562 2500004	.500 2500003
	10,000'	#10 2500052	#39 2500029	.70"W.C. 2100013	.70"W.C. 2100013	.875 2500002	.875 2500002	.562 2500004	.500 2500003
	11,000'	#10 2500052	#39 2500029	.70"W.C. 2100013	.70"W.C. 2100013	.875 2500002	.875 2500002	.562 2500004	.500 2500003

MODEL NO. GB130									
	SEA LEVEL	#11 2500030	#28 2500025	5.0"W.C. 2100029	5.0"W.C. 2100029	.750 2500008	.750 2500008	.750 2500008	.687 2500008
	3000'	#11 2500030	#32 2500035	5.0"W.C. 2100029	5.0"W.C. 2100029	.750 2500008	.750 2500008	.750 2500008	.687 2500008
	4000'	#11 2500030	#32 2500035	5.0"W.C. 2100029	5.0"W.C. 2100029	.750 2500008	.750 2500008	.750 2500008	.687 2500008
	5000'	#11 2500030	#33 2500036	5.0"W.C. 2100029	5.0"W.C. 2100029	.750 2500008	.750 2500008	.750 2500008	.687 2500008
	6000'	#11 2500030	#34 2500037	5.0"W.C. 2100029	5.0"W.C. 2100029	.750 2500008	.750 2500008	.750 2500008	.687 2500008
	7000'	#11 2500030	#36 2500050	4.0"W.C. 2100015	4.0"W.C. 2100015	.750 2500008	.750 2500008	.750 2500008	.687 2500008
	8000'	#11 2500030	#36 2500050	4.0"W.C 2100015	4.0"W.C 2100015	.750 2500008	.750 2500008	.750 2500008	.687 2500008
	9000'	#11 2500030	#38 2500027	4.0"W.C 2100015	4.0"W.C 2100015	.750 2500008	.750 2500008	.750 2500008	.687 2500008
	10,000'	#12 2500031	#39 2500039	4.0"W.C 2100015	4.0"W.C 2100015	.750 2500008	.750 2500008	.750 2500008	.687 2500008
	11,000'	#12 2500031	#41 2500055	4.0"W.C 2100015	4.0"W.C 2100015	.750 2500008	.750 2500008	.750 2500008	.687 2500008

MODEL NO.

GB160

	GAS ORIFICE SIZE/PART NUMBER		AIR PRESS. SWITCH SETTTING/PART NO.		SUCTION AIR ORIFICE SIZE'PART NO.		DISCHARGE AIR ORIFICE SIZE/PART NO.	
ALT	NAT	LP	NAT	LP	NAT	LP	NAT	LP
SEA LEVEL	#2 2500042	#23 2500046	5.0"W.C. 2100029	5.0"W.C. 2100029	.875 2500002	.875 2500002	NOT USED	NOT USED
3000'	#2 2500042	#27 2500028	4.0"W.C. 2100015	4.0"W.C. 2100015	.875 2500002	.875 2500002	NOT USED	NOT USED
4000'	#2 2500042	#27 2500028	4.0"W.C. 2100015	4.0"W.C. 2100015	.875 2500002	.875 2500002	NOT USED	NOT USED
5000'	#2 2500042	#29 2500048	4.0"W.C. 2100015	4.0"W.C. 2100015	.875 2500002	.875 2500002	NOT USED	NOT USED
6000'	#2 2500042	#29 2500048	4.0"W.C. 2100015	4.0"W.C. 2100015	.875 2500002	.875 2500002	NOT USED	NOT USED
7000'	#2 2500042	#31 2500054	4.0"W.C. 2100015	4.0"W.C. 2100015	.875 2500002	.875 2500002	NOT USED	NOT USED
8000'	#2 2500042	#31 2500054	4.0"W.C. 2100015	4.0"W.C. 2100015	.875 2500002	.875 2500002	NOT USED	NOT USED
9000'	#2 2500042	#33 2500036	4.0"W.C. 2100015	4.0"W.C. 2100015	.875 2500002	.875 2500002	NOT USED	NOT USED
10,000'	#3 2500043	#34 2500037	2.0"W.C. 2100006	2.0"W.C. 2100006	.875 2500002	.875 2500002	NOT USED	NOT USED
11,000'	#3 2500043	#34 2500043	2.0"W.C. 2100006	2.0"W.C. 2100006	.875 2500002	.875 2500002	NOT USED	NOT USED

The combustion air orifice is press fit in the special 1›" black iron pipe nipple upstream of the reducing tee on the suction side of the combustion air blower. The orifice is in the end of the nipple which is threaded into the reducing tee. This nipple is also tapped upstream of the combustion air orifice to accept the adaptor fitting for the combustion air pressure switch's low pressure side and the vent tubing for the gas valve pressure regulator.

By tying the gas valve's pressure regulator into the intake piping, any restriction to air flow will cause an automatic reduction of the unit's firing and help keep gas/air mixtures proper over a wider operating range as an aid in preventing incomplete combustion and the production of noxious carbon monoxide.

7.4.5. DISCHARGE ORIFICE

The discharge orifice is press fit in the special 1›" black iron nipple downstream of the combustion air blower. This orifice presents the last metering step in supplying the correct amount of premixed gas and air to the burner. The GB16014 (160,000 BTU) boiler uses the full flow of the 1›" pipe. No discharge orifice is installed in the GB16014 boiler.

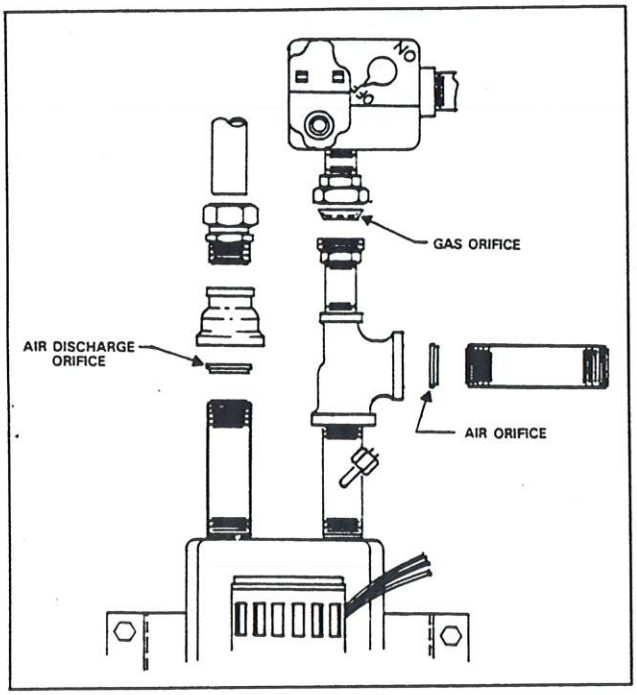


FIG. 7.4.5. *Location of discharge and intake orifices.*

7.4.6. BURNER ASSEMBLY

The burner is a rigid stainless steel pipe wrapped with a woven stainless steel mesh fabric which acts as the flame spreader, each opening in the mesh functioning as a minute burner port to give a steady, even flame with a great deal of surface area for optimum heat transfer. The burner extends down into the combustion chamber and is surrounded by water flowing through the heat exchanger's finned tubing.

The burner is mounted to the heat exchanger's shell with six stainless steel screws and a fiber gasket to provide a positive seal preventing the escape of gases. When installing the burner the screws should be coated with a high temperature RTV silicone sealant to prevent leaking gases and to ease screw removal at a later date.

The burner assembly also provides the mounting plate for the igniter/sensor assembly and a sight glass through which the flame can be observed.

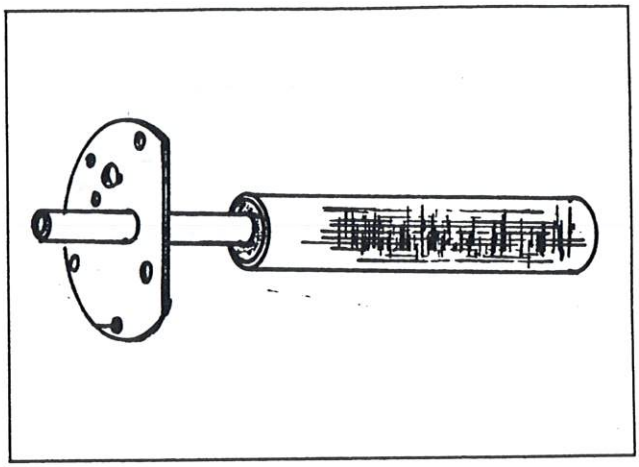


FIG. 7.4.6. *GB series burner.*

7.4.7. DIRECT SPARK IGNITER/SENSOR ASSEMBLY

The igniter/sensor assembly on spark ignition models consists of three rods, two with ceramic insulators and one bare, which provide the ignition spark, flame sensing, and grounding of the spark, mounted to a single plate which is in turn mounted on the burner assembly plate. With the burner removed, gaps for the three rods can be set and will remain unchanged when the burner assembly is reinstalled.

When installing the two #4-40 or #6-40 screws to mount the igniter/sensor assembly, apply a coating of high temperature RTV sealant to the threads to

prevent any gas leakage and to ease the subsequent removal of the screws.

Check the igniter/sensor assembly periodically for wear and deterioration, adjust or replace as necessary. Set the gaps as described in SEC. 8.1.4.

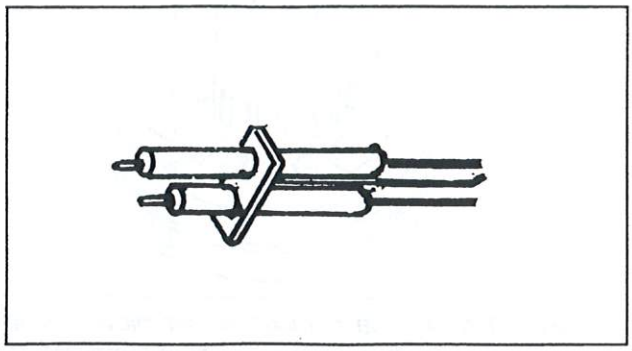


FIG. 7.4.7. *Spark igniter and sensor assembly are replaced as a unit.*

7.4.8. HOT SURFACE IGNITER/SENSOR

Boilers produced since serial number 895300000 are equipped with hot surface ignition systems. The igniter is made of silicon carbide material which when supplied with 115 volts heats to about 2000°F. and gives consistent lighting. The igniter also senses proper ignition through flame rectification.

These igniters are quite fragile and must be handled carefully to avoid breaking but when installed require much less attention and maintenance than direct spark igniters since there is no gap to be set.

7.4.9. DIRECT SPARK IGNITION CONTROL MODULE

The ignition control module provides the circuitry necessary to generate a high voltage spark between the igniter and ground rods, to sense combustion through the flame's ability to rectify AC current to DC, and to shut off the flow of gas should the flame fail for any reason.

Two models of direct spark ignition control are used on the GB boiler; either Honeywell's S87D which gives a single 11 second try for ignition before lockout, or White-Roger's 50D20 which provides four 7 second tries for ignition before lockout. Except for the difference in the high voltage leads, the two are interchangeable.

If either module goes into a lockout condition power must be interrupted to the unit for about 30 seconds to allow the unit to reset. Power is provided to the ignition control through all the safety circuits of the boiler and the ignition control in turn controls power to the gas valve.

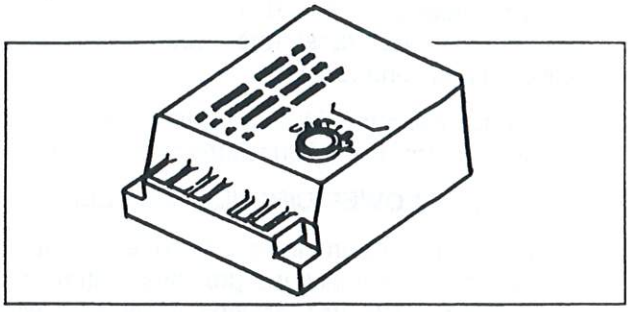


FIG. 7.4.9. *Ignition control modules.*

7.4.10. HOT SURFACE IGNITION CONTROL MODULE

Boilers produced since serial number 895300000 are equipped with hot surface ignition systems. The ignition control module differs in that instead of producing 20,000 volts across a gap as in direct spark, the control produces a 115 volt current to the igniter. Flame rectification proves flame in essentially the same way as the direct spark ignition controller.

Hot surface ignition controls must be supplied with both a line voltage circuit and a 24 volt control circuit. The controller produces a 24 volt signal to operate the gas valve.

Two different controls are approved for use with the GB boiler: Fenwall's 05-32 HSI, and Honeywell's S89G. The controls are interchangeable, both give a prepurge and heat up cycle and multiple tries for ignition.

7.4.11. JUNCTION BOX

A 4" by 4" metal junction box is provided for incoming line voltage within the boiler cabinet. Units produced since serial number 910100000 include a terminal strip within this box to improve wiring ease. Previous units used wire nuts within the junction box for the same purpose.

7.4.12. CONTROL TRANSFORMER ASSEMBLY

The control transformer assembly, mounted on the 4" x 4" electrical box plate, contains the 24 volt power for safety, ignition, and control functions, and the receptacle for the combustion air blower/circulator control relay.

The transformer is rated 25 vac at 40 va and is intended only to power the internal devices of the boiler. An isolation relay and separate power source may be needed with certain digital thermostats and additional power transformers are needed to control diverter and zone valves.

The relay base provided accepts a standard plug-in relay to control 110 volt functions of the boiler.

7.4.13. R1 BLOWER/CIRCULATOR RELAY

The relay mounts on the base provided on the control transformer assembly and provides switching of the two primary 125 vac devices associated with the boiler, the combustion air blower and the circulator. The double pole, single throw relay has contacts for both functions. The pump circuit must be field wired through the relay base.

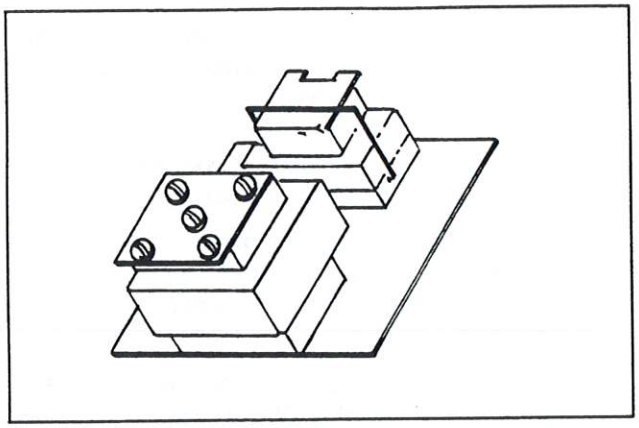


FIG. 7.4.12. *25vac power transformer provides low voltage for internal controls and the assembly provides a base for the relay which controls the combustion air blower.*

Power is provided to the relay's coil through the excess temperature limit switch and the water pressure switch. Other controls in the circuit will not interrupt power to the relay's coil.

7.4.14. COMBUSTION AIR BLOWER

The combustion air blower is a cast aluminum, dynamically balanced centrifugal compressor which draws in combustion air, mixes the air and gas, supplies the gas/air mixture under positive pressure to the burner, drives the hot gases through the heat exchanger, and expels the by-products of combustion through the vent piping to the outside. The combustion air blower assembly includes a silencer to attenuate the sounds created by the high velocity of the air within the blower.

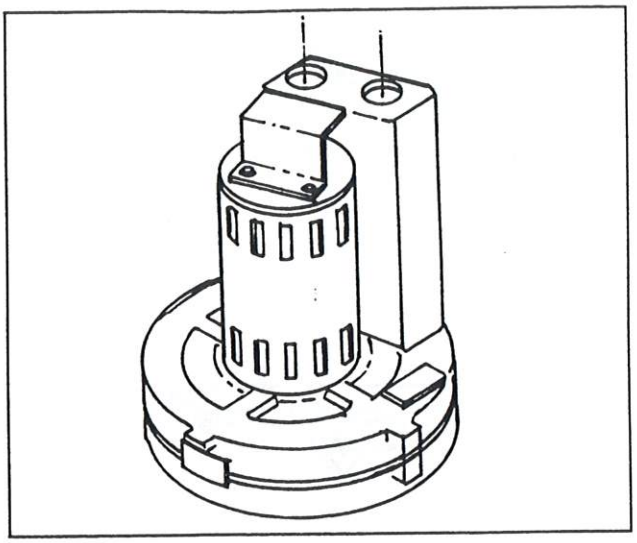


FIG. 7.4.14. *The combustion air blower is located ahead of the burner to avoid high temperatures and corrosive condensate.*

Because of the close tolerances involved in this type of blower, the motor, blower, and silencer are replaced as a unit. No field repair is possible.

The blower is driven by a 1/4hp, 125 vac, 3450 rpm permanent split capacitor motor which contains permanently lubricated motor bearings. No maintenance is required on this component.

7.4.15. COMBUSTION AIR BLOWER MOTOR RUN CAPACITOR

A 12.5 micro farad, 125 vac capacitor mounted on the side of the boiler's heat exchanger bulkhead provides proper run characteristics for the combustion air blower in GB0407, GB0607, and GB0907 boilers. A 15.0 micro farad, 125 vac capacitor is used in GB13010 and GB16014 boilers.

7.4.16. GAS VALVE

The gas valve is a standard combination type redundant (100% shutoff) valve with an 24 vac electric valve operating coil and built in pilot safety and is rated at pressures to ‹ psig and a maximum capacity of 250,000 BTU/hr. It is located directly above and upstream from the combustion air blower inlet. The gas valve is controlled by the ignition control module.

The gas valve contains a pressure regulator which can be adjusted if necessary to achieve the proper input and combustion gas analyses for optimum operation.

The pressure regulator's vent is tied into the negative pressure present in the combustion air intake piping upstream from the combustion air orifice by a piece of flexible aluminum tubing. This insures that any restriction of intake air will also restrict the amount of gas available to the burner in order to prevent a "too rich" fuel air mixture and resultant improper combustion.

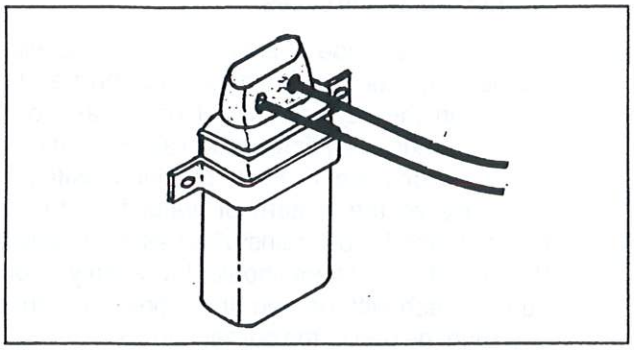


FIG. 7.4.15. *Blower motor run capacitor.*

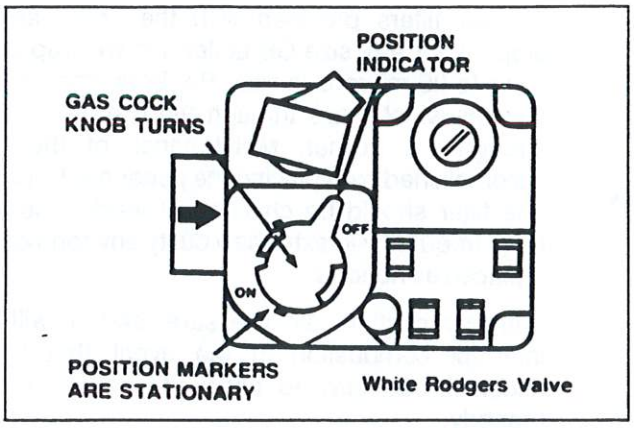


FIG. 7.4.16. *Dual function gas valve has two operators and operates under positive pressure.*

7.4.17. HEAT EXCHANGER

The boiler shell is the primary heat exchanger which, through its combustion chamber and finned coil, transfers the heat produced in the hot gases of the combustion process into the circulating water. Head characteristics of the boiler coil are shown in the accompanying chart and must be considered in the overall system head when selecting the pump(s) to drive the system.

The boiler shell has been designed to operate at a nominal flow of 1 GPM per 10,000 BTU of output to yield a 20°F rise through the heat exchanger.

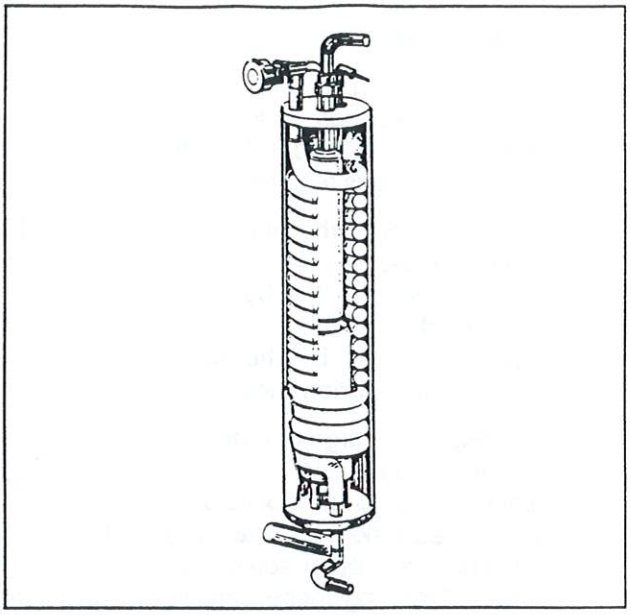


FIG. 7.4.17. *Cutaway of the heat exchanger shows finned coil and restrictor.*

For instance, a 90,000 boiler with rated output of 81,000 BTU will require a flow of about 8 GPM to yield the proper temperature rise. A temperature rise of less than 20 degrees, usually resulting from flows greater than 1 GPM per 10,000 BTU output, will only enhance the efficiency of the boiler. A temperature rise of more than twenty degrees will be detrimental to boiler operation and may lead to erratic operation and excessive cycling resulting in increased service problems and possible noise generated when water in the boiler flashes to steam.

The boiler heat exchanger is made up of a cupronickle coil with stainless steel fins inside a welded stainless steel shell. All GB boiler heat exchangers are ASME certified for operating pressures up to 100 psig. Refractory material in the upper part of the combustion chamber protects the metal of the shell from excessive temperatures and a restrictor core in the center of the lower part of the heat exchanger coil forces the hot gases to flow through the fins for maximum heat transfer.

Water is pumped from bottom to top through the heat exchanger while hot gases are pumped from top to bottom. This counterflow arrangement optimizes heat transfer in all areas of the boiler.

8. MAINTENANCE

The combustion air blowers contain permanently lubricated bearings which need no maintenance. Properly installed and set up, the unit burns cleanly and no cleaning is required of the vent system.

The installation of the air filter provided with the boiler in the combustion air intake line will greatly reduce the need for cleaning the burner and heat exchanger. Airborn dirt and dust larger than 50 microns in size may be trapped by the burner and will lead to improper combustion because of air flow restriction.

Because of the large volume of air flowing through the system for combustion, in the millions of cubic feet per year even with smaller boilers, particles present in the air from automotive exhaust, household dust, road salt, and many other sources over time will plug the burner. Trapping these particles in an air filter will prevent the need for cleaning the burner.

8.1. BURNER MAINTENANCE

The burner may require cleaning on a periodic basis. How often the burner will need to be cleaned will depend on the quality of the combustion air. Dusty conditions or air contaminated with solvents, paints, automotive exhaust fumes or the like at the air intake will require more frequent cleaning. GlowCore recommends that the burner be inspected at least annually and cleaned if necessary.

8.1.1. REMOVING AND REINSTALLING THE BURNER

The burner will need to be removed to inspect ignitor assembly and set gaps, to inspect and clean the burner, and to inspect and clean the combustion chamber.

Turn off gas and electric supplies to the boiler and remove the boiler cabinet top panel. With a 1›" open end wrench loosen the compression fittings on each end of the gas/air tube at the burner and combustion air blower and remove the pipe. Disconnect the high voltage lead to the ignitor rod and the flame sensor (blue) lead to the sensor rod or the two white wires to the hot surface igniter.

With a 5/16" nut driver or common screwdriver, remove the six 10/32 stainless steel hex head tapping screws which mount the burner to the top of the boiler shell. When reinstalling the burner replace the burner gasket and coat the threads of the mounting screws with high-temperature RTV silicone sealant or an equivalent anti-seize material to ease subsequent removal of the burner.

8.1.2. CLEANING THE BURNER

Any of a number of methods may be used to clean the burner depending on what contaminant is present on the burner. With the burner removed, use compressed air to blow loose dust from the burner. Wash the burner with a detergent and water and flush with clear water or use an acid solution such as refrigeration coil cleaner, muriatic acid, or commercial drain cleaner in extreme cases.

The burner is made of stainless steel and will not be harmed by such chemicals. The burner may be soaked in the acid solution if necessary to remove residues caused by combustion air contaminated with chemicals or solvents. Flush the burner with tap water and observe the pattern of water flow through the burner mesh before reinstalling as described above. Water under pressure should flow evenly through the burner mesh with no one area showing more or less flow than the rest of the burner surface.

8.1.3. AIR FILTER

The air filters provided with the boiler are sized properly for any size GB boiler and will trap particles down to 25 microns in size. Particles smaller than 25 microns which pass through the filter will also pass through the burner. Maintenance of the filter is accomplished by replacing the paper media cartridge. The filter should be checked at least once a year, more frequently in extremely dusty environments, and replaced as needed.

The combustion air pressure switch will safely interrupt combustion in the event that the filter becomes too dirty to allow the boiler to operate properly.

8.1.4. SETTING IGNITOR/SENSOR ELECTRODES

When cleaning and inspecting the burner, check for proper ignitor/sensor/ground rod gaps. Some warping or erosion of the rods may be possible over time. Replace the ignitors if necessary with the proper replacement part and set the spark gaps as indicated in the accompanying chart. Replace the fiber gasket between the ignitor rod assembly and the burner mounting plate each time the ignitors are removed and reinstalled.

RISK OF ELECTRICAL SHOCK IN THE FOLLOWING PROCEDURE. BE CERTAIN THAT GAS IS TURNED OFF AND BURNER IS CLAMPED SECURELY TO THE FURNACE CABINET AND PROPERLY GROUNDED. DO NOT TOUCH IGNITER OR BURNER WHILE ELECTRICITY IS TURNED ON.

WARNING

With the burner removed, bend the ignitor and sensor rods to the specifications shown in FIG. 8.1.4. This process can be made easier by using a feeler gauge made from wooden dowel rod or tubing with the appropriate outside diameter. Bend the ground rod toward the ignitor rod and set the proper gap.

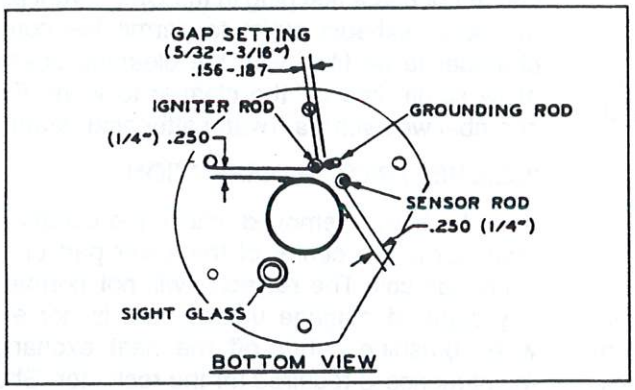


FIG. 8.1.4. *Proper igniter and sensor gaps are critical for dependable lighting of the burner.*

Proper spark operation can be checked visually with the burner removed. Be sure main gas valve is off before proceeding with the following test. A high voltage spark is generated so do not touch electrical components during this test as there is a strong risk of electrical shock.

Clamp the burner to the boiler cabinet close enough to the ignitor control to allow the high voltage lead to be connected. Be sure the burner is grounded. With the gas turned off and R to W terminals made, cycle the unit and observe the spark produced.

HIGH VOLTAGE ARC PRESENT. BE CERTAIN GAS IS TURNED OFF. DO NOT TOUCH IGNITER OR BURNER WHILE ELECTRICITY IS TURNED ON.

WARNING

An electrical arc will be observed between the igniter rod and ground rod only. No arc should be observed between the ignitor and the face of the burner or to the sensor rod.

8.1.5. REPLACING THE IGNITER ASSEMBLY

With the burner removed as above, remove the two 6/40 (4/40 on earlier models) stainless steel hex head tapping screws which mount the assembly to the burner mounting plate. Replace the ignitor gasket and ignitor assembly with the appropriate part and set the gaps as described above. Coat the threads of the screws with high temperature RTV silicone sealant or an equivalent anti-seize material to ease subsequent ignitor removal.

8.1.6. HOT SURFACE IGNITER

Hot surface igniters require no routine maintenance. Exercise extreme caution when removing and installing burners since the igniters are very fragile. Inspect the igniter for proper operation and replace if cracked or broken.

8.2. HEAT EXCHANGER MAINTENANCE

Heat exchangers may need cleaning if combustion air is contaminated with chemicals, solvent fumes, or fine particulate matter which can pass through the burner and adhere to the heat exchanger. A buildup of material on the heat exchanger will result in high exhaust temperatures, restriction to the flow of gases, and will ultimately cause the combustion air differential switch to open and shut down the burner.

Some build up of a greenish crystal on the heat exchanger coil is normal and, unless extreme, will not adversely affect heat exchanger performance. These crystals are normally caused by condensate reacting with the cupronickel of the heat exchanger, particularly where combustion air is contaminated with chlorine fumes as from municipal water systems or laundry bleach. If the heat exchanger must be cleaned, use a good grade of nickel-safe coil cleaner as used on air conditioning or ice-maker coils.

COIL CLEANERS CONTAIN ACIDS WHICH CAN CAUSE EYE AND SKIN IRRITATION. USE CAUTION AND PROPER SAFETY EQUIPMENT WHEN HANDLING COIL CLEANERS. DISPOSE OF USED COIL CLEANERS PROPERLY. REFER TO PRODUCT LABELING FOR PROPER PROCEDURES.

Disassemble the union in the condensate trap and insert a plug in the pipe end to allow filling of the heat exchanger with coil cleaner solution or use a plastic condensate pump to continuously flush the heat exchanger surface until clean. Allow adequate time for the solution to work.

Most solutions will work quicker if heated. This can often be accomplished by running the circulator in water heating mode while cleaning. Hot water from the water heater will warm the cleaning solution and speed the process.

After draining the solution, reassemble the condensate trap union and flush thoroughly with water

8.2.1. INSPECTING COMBUSTION CHAMBER

With the burner removed, inspect the fire side of the heat exchanger and the restrictor in the lower section of the heat exchanger for any debris or scaling. Check the area around the top of the restrictor for any foreign matter or any deterioration of the restrictor.

Pay particular attention to the top of the combustion chamber, the area just below the burner mounting surface. Wet pack refractory material must be in place and must be replaced if damaged to protect the shell of the boiler from excessive temperatures. Replace the burner gasket when reinstalling the burner.

8.2.2. CLEANING COMBUSTION CHAMBER

The process of burning gas consumes combustion air in the ratio of about 14 cubic feet of air for each cubic foot of natural gas. A 90,000 BTUH GB boiler will use 1,260 cubic feet of air for each hour of run time. Therefore, any contaminants such as dust, automotive exhaust fumes, or airborne chemical vapors, no matter how minute the concentrations present in combustion air, will tend over time to build up in the filter, burner or combustion chamber. To maintain effective heat transfer, these deposits must be removed if present.

If annual inspection reveals any buildup on the heat exchanger the following procedure is recommended. First, remove any loose debris with a vacuum cleaner. Use a wire brush, a 2‹" boiler brush as used on fire-tube boilers works well, to dislodge any material clinging to the heat exchanger and vacuum out the resulting debris. Avoid physically damaging any of the refractory material, either the boiler core restrictor or the refractory at the top of the combustion chamber. In most cases, the preceding will adequately clean the surfaces.

Flush any remaining fine debris through the boiler with tap water. The water will drain through the condensate trap. Clean out any debris which collects in the condensate trap.

In extreme cases, the heat exchanger can be cleaned with an acid based coil cleaner. Spray the coil with the cleaner or use a test plug in the CPVC vent pipe near the boiler exhaust outlet to permit the combustion chamber to be filled with the cleaning solution and allow some time for the cleaner to work. Flush the chamber well with plain water after acid cleaning.

8.2.3. RESTRICTOR INSPECTION

With the burner removed, check the condition of the restrictor in the center of the lower part of the heat exchange coil. The restrictor will not normally show any signs of damage unless care is not exercised when brushing debris off the heat exchanger. No maintenance is required for the restrictor. Should the restrictor become loose or damaged, flue gases will exceed the maximums stated in SEC. 9.1.1.3. Take flue gas temperature readings by inserting a temperature probe into the exhaust stream through the hole drilled for CO2 testing.

9. TROUBLESHOOTING

Many of the problems seen in the field can be traced and corrected quickly and accurately if a methodical approach is coupled with a basic understanding of the technology and the equipment. In a system with so many individual components, each must do its job correctly for the entire system function. Problems of application may manifest themselves as component failures. By designing systems to be compatible with the boiler, especially in terms of pumping, zone control, and optimum boiler loads, most common problems can be avoided.

The following text attempts to create a path to follow in troubleshooting the GB boiler and lists the tools and instruments necessary to effectively diagnose any problems encountered.

9.1. TOOLS AND INSTRUMENTATION

See the accompanying chart for a list of the suggested tools and instruments and their most common uses. The list includes items to be included in the serviceman's tool kit in addition to normal hand tools. All the tools suggested here will probably already be in most well equipped service trucks.

TOOL/INSTRUMENT	USE FOR
1-1/4" open end wrench	Removal and installation of burner supply tube.
5/16 nut driver	Removal and installation of burner from boiler shell.
3/16 nut driver	Removal and installation of ignitor and sensor assembly.
1/4" O.D. tube or dowel	Feeler gauge to set ignitor and sensor rod gaps.
Volt-ohm meter	Circuit testing, continuity testing.
Digital thermometer	Checking temperature rise through the boiler and temperature drop through system, check exhaust gas temperature. (Differential capability required to take two simultaneous readings)
U-tube manometer	Check gas pressures, troubleshoot burner, gas/air system, venting.
Combustion analyzer	Fine tune combustion for peak performance and dependability.

9.1.1. VITAL SIGNS

The following ranges of values have been established to assist the skilled service person in verifying the proper subcomponent function. Proper tools as listed above and training are necessary to properly measure and interpret the values shown below. Unqualified persons should not attempt to service this equipment.

9.1.1.1. ELECTRICAL VALUES

Low voltage transformer output:	18 VAC at 110 VAC input
	24 VAC at 120 VAC input
Relay coil current draw:	.25 amp
Relay contactor rating:	12 amp
Combustion air blower current draw:	3.0-3.5 amp (GB040, GB060, and GB090)
	3.5-4.0 amp (GB103 and GB160)
Hot surface ignitor current draw:	3.0-5.0 amp
Combustion air blower capacitor:	12.5 mfd 370 VAC (GB040, GB060, & GB090)
	15.0 mfd 370 VAC (GB130 & GB160)

9.1.1.2. GAS PRESSURES

Natural gas supply:	5.0-10.5" w.c. ahead of valve with unit operating
LP gas supply:	11.0-13.0" w.c. ahead of valve with unit operating
Natural gas (regulated)	2.5" w.c. after gas valve with unit operating
LP gas (regulated)	8.5" w.c. after gas valve with unit operating

NOTE: Regulated gas pressures listed above are nominal and will vary depending on the installed orifice and various other factors. Use combustion (CO_2) analysis to determine proper firing. Gas pressures listed are starting points only.

9.1.1.3. TEMPERATURE READINGS

Flue gas maximum temperatures:	240°F (GB040, GB060, & GB090)
	250°F (GB130 and GB160)
Operating limit switch operation:	95-180°F (GB040, GB060, & GB090) Open on rise
	95-195°F (GB103 & GB160) Open on rise
Auxiliary limit switch:	190°F (GB040, GB060, & GB090) Open on rise
	205°F (GB130 & GB160) Open on rise
Excess temp. switch (flue gas)	225°F (all models) Open on rise

NOTE: Flue gas temperature readings should be taken by inserting the temperature probe through the same hole used to take CO_2 readings after the boiler has been running for at least fifteen minutes and has reached normal operating temperatures.

9.1.1.4. AIR PRESSURE READINGS

Combustion air pressure switches monitor proper air flow through the system for proper combustion by reacting to the differential pressure across the intake air orifice. Any obstruction to air flow, either upstream or downstream from the combustion air blower will cause the differential across the orifice to approach zero. Measure differential pressures by connecting both legs of a U-tube manometer to the tubes leading to the combustion air pressure switch. Take readings with the combustion air blower running with and without the unit fired.

The flue gas pressure switch reacts to an increase in the combustion chamber pressure to avoid blowing the water seal out of the condensate trap and spilling products of combustion into the occupied space.

Minimum differential press.	4" w.c. differential (GB040)
	4" w.c. differential (GB060)
	1.1" w.c. differential (GB090)
	5.0" w.c. differential (GB130 & GB160)
Maximum flue gas pressure	6.0" w.c. switch opens on pressure rise (all models)

9.1.1.5. WATER PRESSURE READINGS

The water pressure switch is intended to prevent firing of the boiler with no water in the system by sensing a minimum water pressure of 6 pounds per square inch. Most systems will be operated at pressures at or above 12 psi and the boiler and all connected components are rated for working pressures up to 100 psi according to A.S.M.E. test procedures. Note that the water pressure switch is not capable of differentiating between water and air pressure. If the piping is tested by pressurizing with air, be certain that the boiler does not fire until filled with water. Rapid failure of the heat exchanger will occur if dry-fired and resulting damage is not covered under warranty.

9.2. DEALER PARTS STOCKING

The following list suggests a parts selection and appropriate quantities of repair parts which should be stocked by the dealer to cover emergency replacements. Stocking levels are for new dealers and should be adjusted according to the number and types of units the dealer has installed or intends to install. The suggested parts inventory includes many items which are industry standard and may already be contained in the dealer's parts inventory but may be hard to find locally. Items below marked with an asterisk (*) are available only through GlowCore distributors and are not off-the-shelf products.

SUGGESTED PARTS INVENTORY

QUAN.	PART NO. (OLD)	PART NO. (NEW)	DESCRIPTION
*5	704-2100	1500004	Spark ignitor gasket for GB/UF all
*5	704-2117	1500012	Hot surface ignitor gasket, all models
*5	704-2104	1500010	Burner gasket for GB/UF 40, 60, 80 & 90
*5	704-2116	1500011	Burner gasket for all GB 130, 160
2	704-2601	1950004	Spark ignition control module GB/UF all
2	704-2624	1950000	Hot surface ignition control GB/UF all
*2	704-3415	1800003	Burner, spark ign., GB/UF 40, 60, 80, 90
*2	704-3424	1800001	Burner, HSI, GB/UF 40, 60, 80, 90
*2	704-3418	1800004	Burner, spark ignition, GB 130, 160
*2	704-3425	1800002	Burner, HSI, GB 130, 160
*2	704-2600	1950002	Spark ignitor, GB/UF 40, 60, 80, 90
*2	704-2625	1950001	HSI ignitor, GB/UF 40, 60, 80, 90
*2	704-2615	1950008	Spark ignitor GB 130, 160
*2	704-2626	1950006	HSI ignitor, GB 130, 160
5	704-2730	2100026	Water pressure switch (2psi), UF all
5	704-2731	2100027	Water pressure switch (9psi), GB all
2	704-2602	2250002	40 va transformer/relay ass'y, GB/UF all
1	704-3500	1750002	Gas valve, all models GB/UF
1	704-2708	2100012	Flue temp. switch GB/UF 40, 60, 80, 90
1	704-2717	2100016	Flue temp. switch GB 130, 160
2	704-2705	2000000	DPST relay, UF/GB all
2	704-2716	2000004	SPDT relay, cooling relay, UF all
*1	704-1548	2550001	Heat exchanger, UF all
*1	704-1554	2550000	Heat exchanger, GB 40, 60, 90
*1	704-1591	2550002	Heat exchanger, GB 130, 160
1	704-2703	2100009	Fan switch, UF all
1	704-2701	2100007	Aux. limit, UF/GB 40, 60, 80, 90
1	704-2722	2100018	Aux. limit, GB 130, 160
1	704-2702	2100008	Operating limit, UF/GB 40, 60, 80, 90
1	704-2723	2100019	Operating limit, GB 130, 160
*1	704-5704	1050004	Comb. air blower GB/UF 40, 60, 80, 90
*1	704-5717	1050005	Comb. air blower GB 130, 160
*1	704-5203	1600003	Circ. pump assembly, UF all
*1	704-5307	1600014	Circ. pump impeller only, UF all
1	704-4177	1650001	Diverter valve, UF/GB all

All of the above items are carried in GlowCore distributors' inventory but dealers may wish to carry their own inventory for emergency no-heat situations.

10. FEATURES OF THE UF SERIES FURNACE

The GlowCore UF furnace is unique in its concept and design from virtually all other furnaces. While the applications for which the furnace was designed are the same as those in which other furnaces are used, the UF furnace has certain features which not only make it more efficient but also present some design considerations which must be addressed to achieve the efficiency and reliability which have been designed into the boiler. FIG 10. shows the basic components and configuration of the UF series warm air furnace.

The UF furnace is designed as a condensing, high-efficiency warm air furnace with materials selected to give maximum resistance to the effects of corrosive condensates. As a hydronic-based furnace, the UF series is also capable of providing domestic hot water with the addition of a properly selected WT series water heater. Water heating recovery rates are much higher than standard water heaters and produce water heating efficiencies between 88 and 90%.

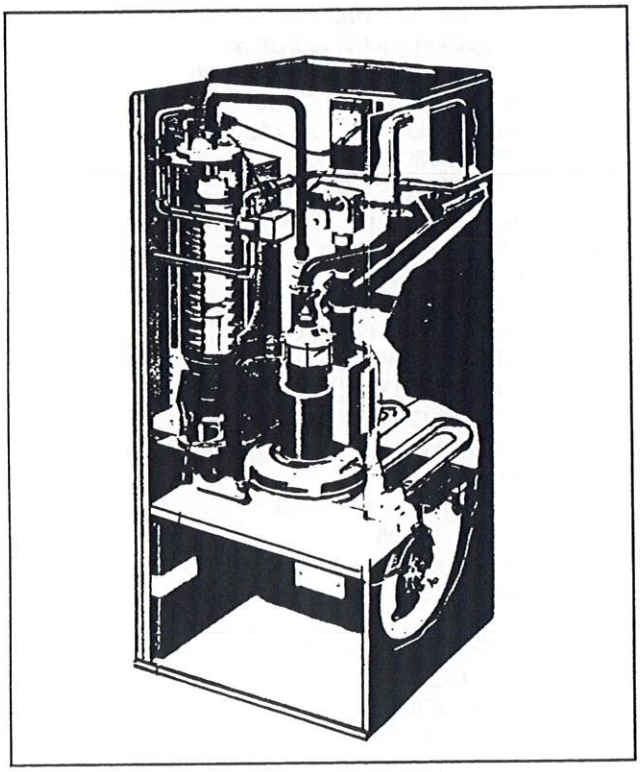


FIG. 10. *Cutaway view of UF series furnace.*

The following text attempts to create a clear and logical path to follow in designing a new heating system or evaluating the existing system as to the applicability of the distribution system, the selection of the proper replacement equipment, the location of the new furnace and components, and the method of replacement--either retrofit or new construction--in residential applications.

10.1. NEW SYSTEM VS. RETROFIT SYSTEM

In this manual a new system is regarded as being any system which utilizes all new components properly selected and sized for the application in question. Retrofit systems are those which make use of existing components, particularly the ductwork and heating runs which present parameters within which the furnace system must be designed for proper operation.

10.2. HYDRONIC FURNACE VS. HOT AIR FURNACE

Reduced to its simplest form, the UF series furnace is a low mass, high efficiency boiler with a finned coil heat exchanger. Heat transfer fluid, in most cases water, is heated in the boiler shell and pumped to the air coil where the heat is extracted by the forced flow of air moving across the coil. The heated air is then moved through the house as with any forced air heating system.

Because of the ability of water to absorb heat, the primary heat exchanger can be kept quite compact. In addition, the metal used in the "air-to-water" heat exchanger is kept much cooler than a similar clam-shell-type heat exchanger. The boiler water absorbs heat quickly and metal temperatures by comparison are kept quite low. Typically forced air furnaces have heat exchanger metal temperatures above 500°F., even in high efficiency models.

GlowCore's design, which extracts heat quickly from the burning environment, produces far fewer nitrogen oxide (NOx) emissions than most other types of furnaces.

With the addition of a diverter valve to control the flow of heat transfer fluid and a "water-to-water" heat exchanger/storage tank in the form of GlowCore's WTSS series water tank, domestic water heating needs can be met with the same high efficiency system. Superior recovery rates and efficiency are achieved.

10.3. APPLICATIONS

The UF series furnace is intended for use in standard warm air residential heating applications with auxiliary use to heat hot water.

The heat exchanger *HAS NOT* been tested or approved for use as a pressurized boiler. If a pressurized system is required, a GlowCore GB series hydronic boiler is indicated. Warm air distribution with a boiler system is possible with the UniCore Jr. (HWF or VDX-HW series) air handler.

11. FURNACE SYSTEM DESIGN

The following text attempts to create a logical step-by-step procedure to follow when designing the installation of a UF series furnace. For any forced air heating system, proper air flow through the duct system is vital to satisfactory operation. In all applications involving air conditioning, the required air flow for cooling is the determining factor. Air conditioning typically requires greater air flow through the system than does heating. Even when designing a system that is specified without cooling, the cooling load should be considered to enable the installation of an add-on cooling system at a later date.

11.1. STEP 1: TALK WITH THE HOMEOWNER

Begin the design process by talking with the homeowner about expectations and accessory equipment. Discuss cooling, humidification, air cleaning, and domestic water heating to develop an overview of the requirements for the system.

In retrofit applications where the existing ductwork is to be used, ask the homeowner about any areas of the house that are not heated or cooled to the owner's satisfaction. Problem areas indicate poor duct design which probably can not be overcome by the installation of a new furnace. Be sure to correct duct problems first to avoid unpleasant surprises and callbacks.

Ask also about the homeowner's domestic hot water needs. The UF furnace with the WT series indirect-fired water heater will produce triple the hot water of standard gas-fired water heaters at a much greater efficiency.

The UF furnace can not properly be applied to hydronic zones in combination with forced warm air. These types of applications, forced air heat with forced hot water radiation zones, are possible with the GB series boiler and HWF or VDX series air handlers. The UF furnace is designed as an open system boiler within the context of the furnace and water heater functions only. The UF furnace and WT series water tank are designed to operate in an open system and the furnace is designed with an open expansion tank. Placing hydronic zones above the tank would cause the boiler water to overflow the expansion tank and render the system inoperable.

11.2. STEP 2: CALCULATE HEAT LOSS

Perform a room by room heat loss calculation according to ASHRAE (American Society of Heating, Refrigeration, and Air-Conditioning Engineers) standards to determine how much heat and air flow is needed in each room and the building's total heat loss to determine which size UF furnace is appropriate.

Each room's heat loss will determine the proper air flow required to each room and will help in selecting the proper size and number of registers in each room.

If air conditioning is to be installed, heat gain must also be calculated. Use the required air flow for air conditioning to design the ductwork. Air flows required for heating are normally less than those required for cooling, so a system properly designed for cooling will likely give satisfactory results for heating.

Oversizing the furnace for any application will lead to short-cycling of the burner and may lead to annoying service problems. Match the heat loss of the building to the output of the furnace. Both the UF060D14R and the UF080D14R furnace are capable of 1400 cubic feet per minute air flow against a .5" w.c. static, suitable for up to 4 tons (48,000 BTUh) of cooling at 350 CFM per ton of cooling or 3.5 tons at 400 CFM per ton. Use 400 CFM per ton in areas which normally see high temperatures accompanied by high humidity levels.

No additional capacity is normally needed for domestic water heating. Water heating loads are intermittent and will be easily accomplished by the excess capacity which is inherent in such systems, even if the furnace's output is close to the calculated heat load.

11.3. STEP 3: CALCULATE HEAT GAIN

Use the ASHRAE method to calculate heat gain, the amount of heat and humidity which must be removed from the environment to maintain a predetermined comfort level. Choose the proper air conditioning condenser and evaporator combination. Oversizing the air conditioning units will give fast cool down but will not achieve proper run times to accomplish dehumidification which can lead to a cold, damp environment. An oversized air conditioner may cool the air so rapidly that condensation which forms on the evaporator coil may freeze preventing air flow through the system and resulting in a total lack of cooling. If the system is oversized for the application, compressor life is shortened.

Undersizing the air conditioning may lead to an inability to keep the temperatures as low as desired but humidity levels will be much lower in the building and the environment may seem comfortable at higher temperatures.

11.4. STEP 4: SELECT CORRECT FURNACE

Match the calculated heat loss with the output of the furnace to select the proper size of furnace. The UF series furnace comes as a 60,000 BTUh input (UF060D14R) with an output of 54,510 and an 80,000 BTUh input (UF080D14R) with an output of 72,400.

Unless the calculated heat loss is greater than 54,000 BTUh, do not install the UF080D14R. Buildings with total calculated heat loss below 30,000 BTUh should probably not have a UF060D14R installed because of the lack of adequate load on the furnace and the subsequent burner short-cycling which is likely to occur. Short-cycling will limit the efficiency of the system and may lead to service problems with the unit because of the excessive number of on-off cycles.

UF series furnace are designed in upflow configurations only with return air on either side or through the bottom of the cabinet. If a horizontal or downflow furnace is needed, use a GB boiler with the proper air handler.

11.5. STEP 5: DESIGN WATER HEATING APPLICATION

The water heating function always takes precedence over heating in a UF furnace-WT water heater installation, a process which normally takes between 10 and 20 minutes depending on the output of the furnace, the size of tank, and the thermostat setting of the tank. When a demand for water heating is present, all of the furnace's output is dedicated to heating the water until satisfied. Heating is resumed automatically when the water heater thermostat is satisfied.

WT series water tanks are available in sizes from 30 to 60 gallons of storage capacity. Recovery rates are the same for any size tank selected for a given furnace but the amount of hot water available for immediate use is greater for the larger tank sizes. A larger tank size would be indicated if the home has a whirlpool or other large bathtub, or a large family requiring numerous showers or baths in a relatively short time period.

If the water tank must be located remotely from the furnace, a bronze booster pump will be required in the water tank's boiler loop piping. Pipe the water heater with 1" rigid copper tubing for best flow characteristics

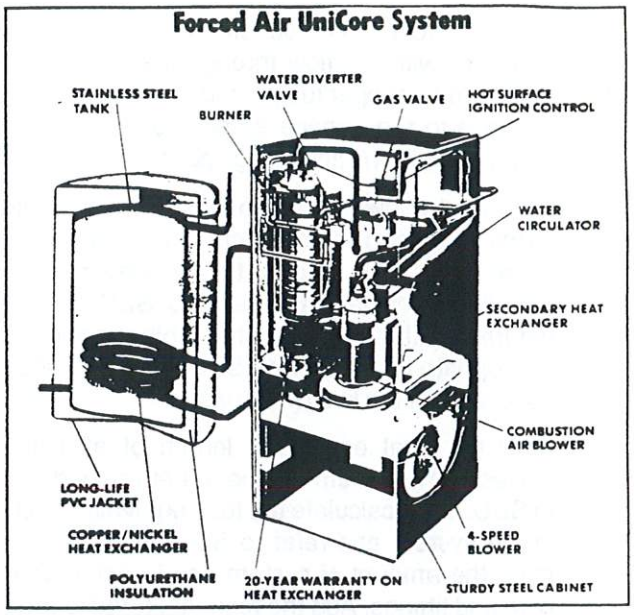


FIG 11.5. *Integrated furnace and water heating with UF furnace and WT water heater.*

and least piping friction. An adequate flow of boiler water is essential to the proper operation of the water heater. Proper flow rates are 5‹ gallons per minute for the UF060D14R and 7 GPM for the UF080D14R.

Expressed as total equivalent length of pipe, the internal water circulator can deliver proper flow to the water heater through up to 100' of 1" rigid copper pipe. Allow proper equivalent length for each 90 degree elbow (see SEC 26.1). Up to 200 equivalent feet, use 1-1/4" pipe. Use 1-3/4" pipe for up to 300 equivalent feet. Use the preceding as an estimating guideline only. Calculate the total pressure drop of the system (see SEC. 11.5.1, below) to insure proper flow rates.

11.5.1. PIPE FRICTION AND SIZING

Each length of pipe, each fitting, each valve, and each heat exchanger will contribute friction to the water flow within the system and will need to be taken into consideration to insure proper pumping. Restriction to flow is typically expressed in feet of head; the higher the system head, the greater the resistance to flow, and is measured as pressure drop through the system.

Adequate flow is essential to the operation of the UF series furnace. The water circulator in the UF furnace has been designed to overcome the resistance of the boiler coil, piping, and warm air coil at the proper flow rate but has a limited capacity for additional piping pressure drop produced by the piping between the

furnace and the WT series water heater. To avoid problems with low flow through the boiler coil, use a minimum 1" copper tubing and place the water heater as close to the furnace as possible. Use the fewest number of elbows and fittings possible.

SEC. 26.1 shows the friction loss of various fittings in terms of the equivalent length of straight pipe. Add all these equivalent lengths to the amount of straight pipe in the system and refer to SEC. 26.2-26.4 to determine the head of the piping system at the appropriate flow rate. See SEC. 11.5.3 for the proper flow rates for the two UF furnaces.

After the total equivalent length of all fittings and valves in the system has been determined according to SEC. 26.1, calculate the total equivalent feet of pipe in the system and refer to SEC. 26.2-26.4 to determine the amount of system head contributed by the pipe and fittings. Add the resultant head to the boiler's head (See FIG. 11.5.3) for total system head.

After all fittings and valves (see SEC. 11.5.5 for diverter valve pressure drops expressed in feet of head) have been counted and their resistance has been converted to equivalent feet of pipe and added to the actual feet of pipe used in the system, convert the total to hundreds of feet of pipe by dividing total feet by 100 (220' becomes 2.2 hundred feet of pipe), and consult the appropriate graph (FIG. 26.2-26.4) based on the type of pipe to determine the head loss of piping and fittings.

Enter the graph along the vertical axis with the required flow rate in gallons per minute based on the required flow through the boiler. See SEC. 11.5.3. Read across the horizontal line to the intersection with the appropriate size of pipe (diagonal line sloping upward left to right), then read straight up or down from the intersection to the pressure drop in feet of water (head) per 100 feet of pipe on the horizontal axis.

Multiply pressure drop per 100 feet from the graph by the number of hundred feet of pipe (including equivalent feet of pipe for fittings) as calculated above to determine head contributed by the piping system. Add this value to the head contributed by the boiler, diverter valve, and the WT heat exchanger (see SEC. 11.5.4) to determine total system head in order to determine if the integral water circulating pump is adequate (see SEC. 11.5.2) or to select an appropriate pump.

11.5.2. INTERNAL WATER CIRCULATING PUMP CAPACITIES

FIG. 11.5.2 gives the pump performance curve for the internal water circulating pump. Calculate pressure drop in the water heater circuit and compare to this chart to assure adequate flows for good heat transfer and to prevent noise which may result as boiler water flashes to steam when water flows are too slow.

11.5.3. BOILER PRESSURE DROP

FIG. 11.5.3 shows the pressure drop curve resulting from friction in the primary heat exchanger, the boiler tubing, to be used when designing the WT series water heater's boiler water loop. Minimum flows of 5‹ GPM for the 60,000 BTUH furnace and 7 GPM for the 80,000 BTUH furnace are required.

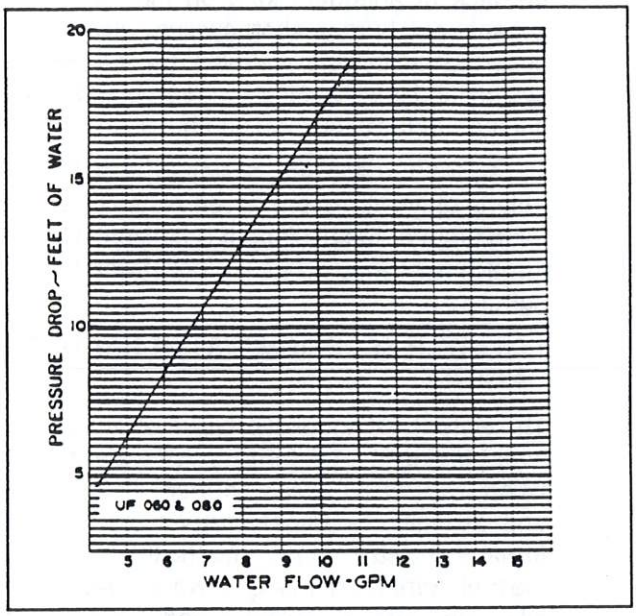


FIG. 11.5.3 *Boiler pressure drop curve.*

11.5.4. PRESSURE DROP THROUGH WT SERIES WATER HEATERS

All three sizes of residential water heaters, WT30SS, WT40SS, and WT60SS, use the same size heat exchanger in the tank. The pressure drop curve of the tank is shown in FIG. 11.5.4. Use the pressure drop from the curve along with the boiler and piping pressure drops to determine if a booster pump is required in the water heater circuit.

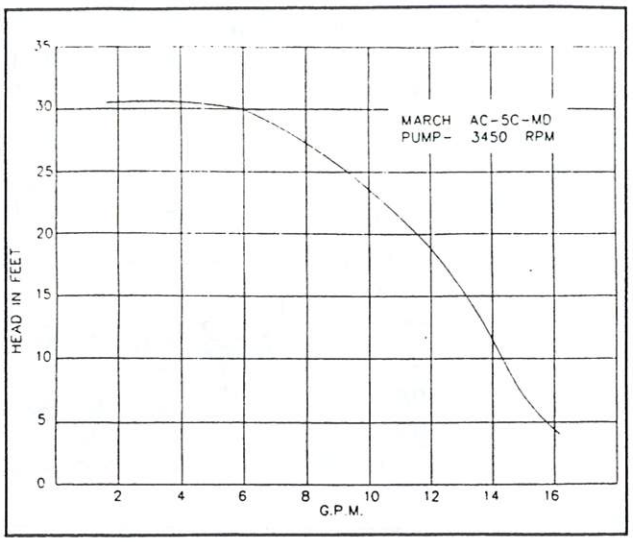


FIG. 11.5.2 *Internal water circulating pump's performance curve.*

The WT30SSD and the WT40SSD residential tanks make use of a double-walled heat exchanger for systems which use antifreeze or where local codes require the use of double-walled heat exchangers in indirect-fired water heater installations. The purpose of the double-walled heat exchanger is to prevent boiler water from mixing with the domestic water in the event of a leak. Both the addition of antifreeze, which increases the need for flow because of the change in the boiler heat exchange solution's ability to absorb heat, and the use of a double-walled heat exchanger, which increases the system pressure drop because of the smaller inside diameter of the pipe required in the double-walled heat exchanger, present an increased need for pumping. If either an antifreeze solution or a double-walled heat exchanger is used, the addition of a bronze booster pump is almost always required. See SEC. 11.5.6.

11.5.5. DIVERTER VALVE PRESSURE DROP

The diverter valve must also be taken into account when determining the total pressure drop of the piping for the WT series water tank. FIG. 11.5.5 shows the amount of head contributed by the diverter valve. Add this figure to total pressure drop before selecting the pump.

11.5.6. BOOSTER PUMP FOR WATER HEATER

If the integral circulator in the UF series furnace is not adequate for the water heater piping, one of two approaches may be used: either install an additional pump which, in conjunction with the integral circulator,

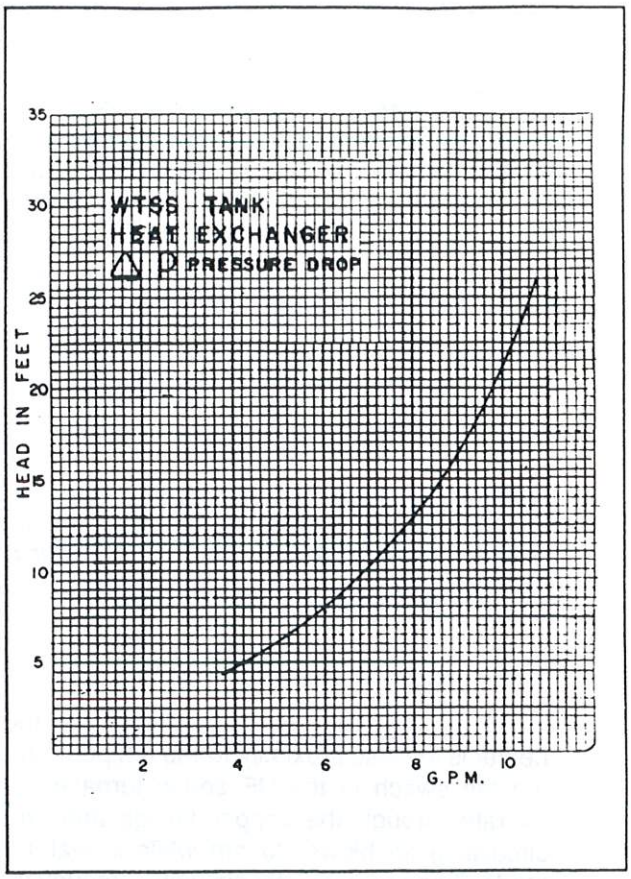


FIG 11.5.4 *Pressure drop curve for the WT water heater's heat exchanger.*

is dissolved in the water in open systems such as the UF furnace.

FIG. 11.5.6 shows the piping and wiring schematics for an external booster pump in the water heater circuit only. The installer must also add a relay to start the booster pump each time there is a call for heat from the water heater. The transformer that powers the diverter valve may also power the pump relay.

2 PORT OR 3 PORT FLAIR VALVE
HIGH FLOW VALVES (SPECIAL)

FLOW GPM	6	8	10	12	14
HEAD FT.	1.64	2.92	4.56	6.57	8.94

FIG. 11.5.5 *Diverter valve pressure drop chart. Because of their high pressure drop at higher flows, 3/4" diverter valves may present design limitations regarding proper water flow through the boiler.*

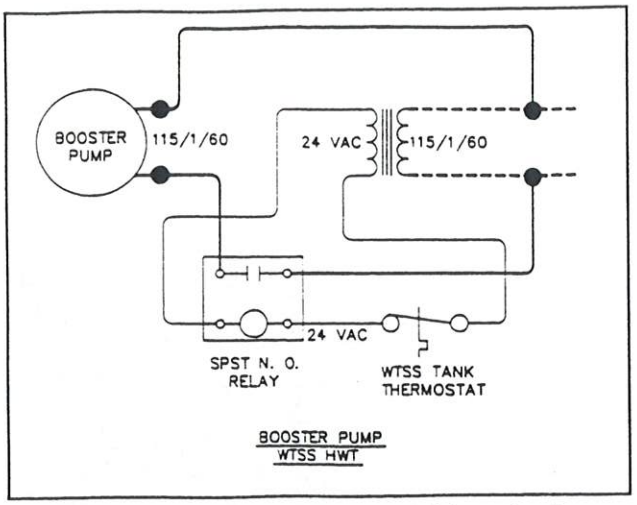


FIG. 11.5.6 *Wiring diagram for addition of a bronze booster pump when required for the water heater's boiler water loop.*

11.5.7. BLOWER CUTOUT RELAY

Since the port for the return water from the water heater is in close proximity to the temperature activated fan switch in the UF series furnace, heat can migrate through the copper fittings and cause the circulating air blower to run while in water heating mode. Since no hot water circulates through the warm air coil during water heating, the movement of cool air through the ductwork may be objectionable. To eliminate the undesirable run of the blower, a blower cutout relay is included in the furnace. See FIG. 11.5.8 for diverter valve wiring schematic.

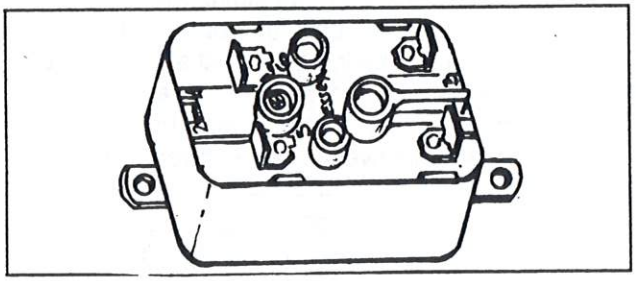


FIG. 11.5.7 *Blower cutout relay.*

11.5.8. DIVERTER VALVE KIT

All service code 4 and later UF furnaces are manufactured with the diverter valve already installed in the system. The installer need only run the piping to the water heater from the plugged port below the diverter valve and back to the plugged return port on the right side of the furnace.

FIG. 11.5.8 shows the wiring schematic for the diverter valve, the blower cutout relay, and the low voltage transformer, all of which are included in the furnace.

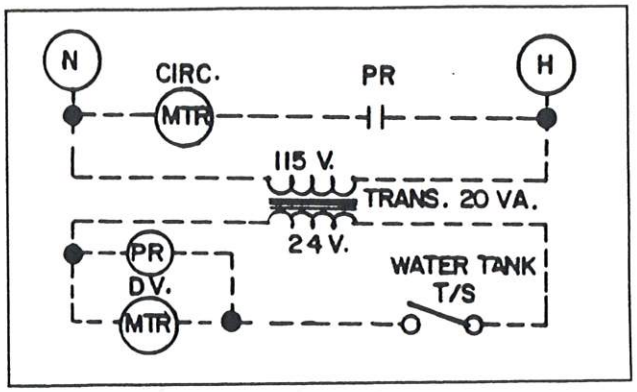


FIG. 11.5.8 *Diverter valve wiring.*

11.6. STEP 6: DESIGN DUCTWORK AND REGISTER LAYOUT

Responsibility for assurances that new or existing ductwork is adequate for the UF furnace lies with the installing contractor. Refer to ACCA (Air Conditioning Contactors of America) Manual D for definitive information regarding duct design.

11.6.1. AIR DISTRIBUTION

All UF series furnaces are equipped with four speed direct drive air circulation blowers. Blower motors are permanently lubricated and require no maintenance beyond occasional cleaning of the blower wheel with a strong vacuum cleaner and brush.

FIG. 11.6.1 shows the blower's capabilities on each of its four speeds. Fan capacities for both the UF060D14R and the UF080D14R are identical. The blower speed set at the factory is medium-low for the 60,000 BTUH furnace and medium-high for the 80,000 BTUH furnace.

11.6.2. PROPER DUCTING

The best compliment to a heating system is that the heating and cooling is largely unnoticed by the occupants; occupants are comfortable and unaware of the operation of the system.

As with any forced air heating and/or cooling system, adequate and properly controlled air flow is critical to the operation of the entire system. That air flow must be delivered through ducting that is large enough to permit proper air flow, yet small enough to keep velocities high enough to prevent excessive loss/gain of temperature at the end of the ductwork.

MODEL NUMBER			UF060 D14R	UF080 D14R
			DD10 - 10T	DD10 - 10T
Air Delivery in C.F.M. Varying Ext. Static Pressure (IN. W.C.)*	ESP	Speeds	4	4
	.10	LO	860	860
		M-LO	1055	1055
		M-HI	1175	1175
		HI	1450	1450
	.20	LO	850	850
		M-LO	1050	1050
		M-HI	1165	1165
		HI	1440	1440
	.30	LO	840	840
		M-LO	1025	1025
		M-HI	1150	1150
		HI	1430	1430
	.40	LO	830	830
		M-LO	1000	1000
		M-HI	1130	1130
		HI	1415	1415
	.50	LO	815	815
		M-LO	980	980
		M-HI	1100	1100
		HI	1400	1400

*Performance data based on left side panel return air connection

FIG. 11.6.1 *Blower performance data for UF series furnaces.*

If excessive restriction exists to the flow of air, the heat delivered to the conditioned space will be inadequate. Too small or too long ductwork will cause the quantity of heated air delivered to the heated environment to be less than needed--too little air delivered--to overcome the heat lost through the building walls, floors, and ceiling.

The effects of inadequate air flow can be measured as excessive air temperature rise across the warm air coil, or as excessive boiler water temperature rise across the boiler heat exchanger.

11.6.3. TEMPERATURE RISE CHARTS

FIG. 11.6.3. shows the relationship between temperature rise and output in BTUH as a function of various air flows. Check temperature rise between the supply and return plenums and choose a fan speed which will produce an acceptable temperature rise of between 40 and 70°F for optimum operation.

Given the output BTUH of the furnace and the measured temperature rise, the air flow rate in CFM can be interpreted from the chart.

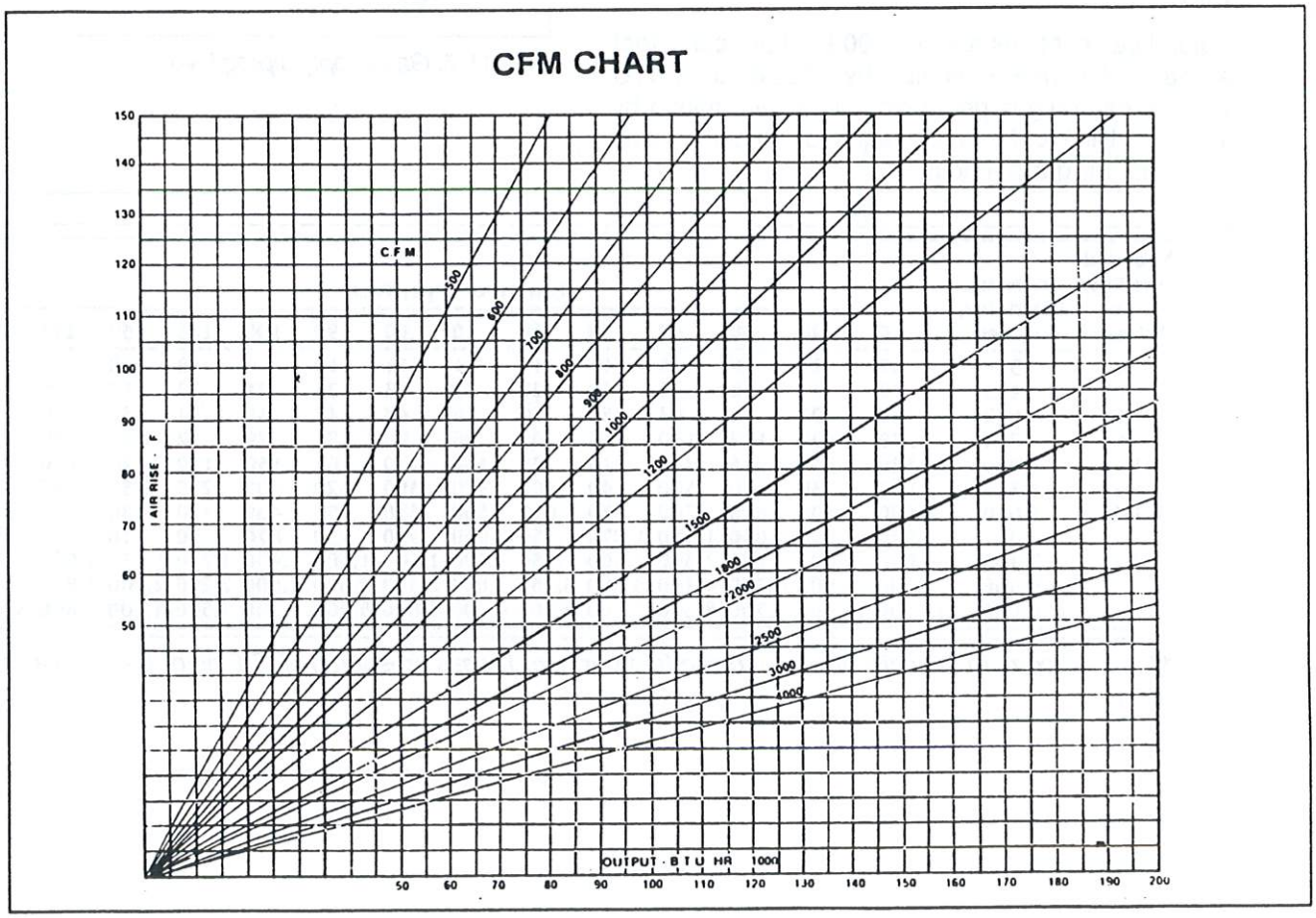


FIG. 11.6.3. *Air temperature rise chart shows the relationship of the air temperature rise, the temperature difference between supply and return air, to the total air flow at a given furnace output.*

11.7. STEP 7: DESIGN GAS PIPING

Design and install gas piping according to requirements set forth in the National Fuel Gas Code ANSI Z223.1--NFPA 54 and all the codes and regulations of the local gas supplier.

Locate a suitable shutoff valve in close proximity to the boiler to allow for interruption of gas flow to the boiler for service and repair functions. FIG. 11.7. shows the recommended configuration of supply piping, drip leg, and gas shutoff valve for the boiler.

11.7.1. NATURAL GAS PIPING

FIG. 11.7.1. shows the amount of natural gas which will pass through various sizes and equivalent lengths of black iron pipe without causing an excessive drop in gas pressure.

Incoming gas pressures must be maintained at not less than 5" of water column (maximum 10.5 ") for natural gas and not less than 11.0" of water column (maximum 13.0") for the proper operation of the gas valve.

Natural gas contains about 1,000 BTU per cubic foot at sea level. Divide boiler input by 1,000 BTU (or BTU value of natural gas per cubic foot as determined by the local utility) to determine required number of cubic feet of natural gas per hour.

11.7.2. LP GAS PIPING

LP gas usually contains between 2,450 and 2,500 BTU per cubic foot. Check with local suppliers for BTU value per cubic foot of LP gas. Divide boiler input by 2,500 BTU (or BTU value per cubic foot as supplied) to determine required flow rates in LP applications. FIG. 11.7.2 lists capacities in thousands of BTU for LP gas in black iron pipe.

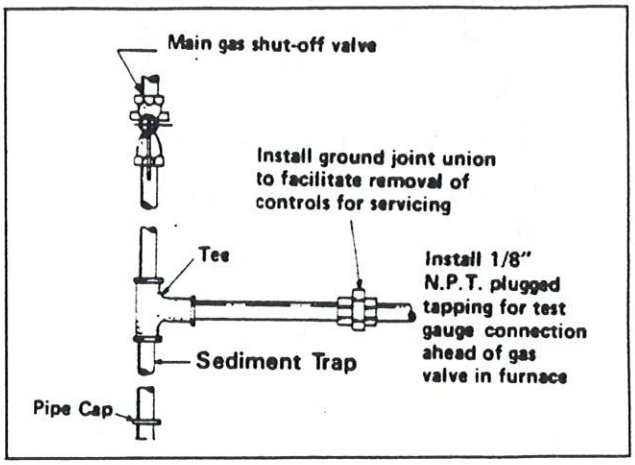

Main gas shut-off valve
Install ground joint union to facilitate removal of controls for servicing
Tee
Install 1/8" N.P.T. plugged tapping for test gauge connection ahead of gas valve in furnace
Sediment Trap
Pipe Cap

FIG. 11.7. *Gas supply piping layout.*

Nominal Iron Pipe Size, Inches	Internal Diameter, Inches	Length of Pipe, Feet													
		10	20	30	40	50	60	70	80	90	100	125	150	175	200
¼	.364	32	22	18	15	14	12	11	11	10	9	8	8	7	6
⅜	.493	72	49	40	34	30	27	25	23	22	21	18	17	15	14
½	.622	132	92	73	63	56	50	46	43	40	38	34	31	28	26
¾	.824	278	190	152	130	115	105	96	90	84	79	72	64	59	55
1	1.049	520	350	285	245	215	195	180	170	160	150	130	120	110	100
1¼	1.380	1,050	730	590	500	440	400	370	350	320	305	275	250	225	210
1½	1.610	1,600	1,100	890	760	670	610	560	530	490	460	410	380	350	320
2	2.067	3,050	2,100	1,650	1,450	1,270	1,150	1,050	990	930	870	780	710	650	610
2½	2.469	4,800	3,300	2,700	2,300	2,000	1,850	1,700	1,600	1,500	1,400	1,250	1,130	1,050	980
3	3.068	8,500	5,900	4,700	4,100	3,600	3,250	3,000	2,800	2,600	2,500	2,200	2,000	1,850	1,700
4	4.026	17,500	12,000	9,700	8,300	7,400	6,800	6,200	5,800	5,400	5,100	4,500	4,100	3,800	3,500

FIG. 11.7.1. *Maximum capacity of pipe in cubic feet per hour for gas pressures of .5 Psig or less and a pressure drop of 0.3" w.c.*

Nominal Iron Pipe Size, Inches	Length of Pipe, Feet											
	10	20	30	40	50	60	70	80	90	100	125	150
½	275	189	152	129	114	103	96	89	83	78	69	63
¾	567	393	315	267	237	217	196	185	173	162	146	132
1	1071	732	590	504	448	409	378	346	322	307	275	252
1¼	2205	1496	1212	1039	913	834	771	724	677	630	567	511
1½	3307	2299	1858	1559	1417	1275	1181	1086	1023	976	866	787
2	6221	4331	3465	2992	2646	2394	2205	2047	1921	1811	1606	1496

FIG. 11.7.2. *Maximum capacity of pipe in thousands of BTUH of LP gas at 11.0" w.c. based on a pressure drop of 0.5" w.c.*

11.7.3. LP GAS DELIVERY THROUGH COPPER TUBING

LP gas piping outside the building is often done with semirigid copper tubing. FIG. 11.7.3 lists capacities for LP gas in semirigid tubing.

Outside Diameter, Inch	Length of Tubing, Feet									
	10	20	30	40	50	60	70	80	90	100
⅜	39	26	21	19	—	—	—	—	—	—
½	92	62	50	41	37	35	31	29	27	26
⅝	199	131	107	90	79	72	67	62	59	55
¾	329	216	181	145	131	121	112	104	95	90
⅞	501	346	277	233	198	187	164	155	146	138

FIG. 11.7.3 *Maximum capacity of semirigid tubing in thousands of BTUH of LP gas at 11.0" w.c. based on a pressure drop of 0.5" w.c.*

11.8. STEP 8: DESIGN LINE VOLTAGE ELECTRICAL SUPPLY CIRCUIT

The UF furnace must be connected to a permanently live, separately fused electric circuit of proper ampacity and must be electrically grounded to assure proper operation of flame rectification circuit.

Provide a service disconnect switch in close proximity to the furnace to allow for ease and safety in servicing the unit.

	UF060 D14R	UF080 D14R
ELECTRICAL DATA (VOLTS, Hz/Ph.) (F.L.A.)	115/60/1 8.2 amps.	115/60/1 8.2 amps.
TRANSFORMER Size (VA)	40	40

FIG. 11.8. *Electrical ratings of UF series furnaces. in accordance with local codes or the National Electrical Code ANSI/NFPA No. 70-1987.*

11.9. STEP 9: CHOOSE VENT/INTAKE CONFIGURATION

UF060D14R and UF080D14R furnaces are each shipped with the proper adapters to attach the 2" PVC exhaust and intake piping to the furnace.

The installer may elect to vent the furnace with separate pipes through the wall for intake and exhaust or the concentric vent/intake kit available as an accessory kit. Vertical venting through the roof of a structure is possible so long as overall permissible vent lengths are not exceeded, applicable codes are observed, and intake air is also taken through the roof or from properly ventilated interior spaces.

Intake air may be taken from a ventilated attic or crawl space in such an arrangement provided no dust or harmful chemical vapors, such as those which offgas from blown-in insulation, are present which could cause the burner to plug. Intake piping which passes through heated space may have a tendency to pro-

duce sweating on the outside of the pipe because of the cold air being drawn through the pipe. Insulate the intake to prevent sweating where necessary.

Be sure all vent pipes slope back to the condensate tee and no low spots or sagging occurs which could trap condensate in the exhaust line. Support vent and intake piping every 2 to 3 feet and allow for pipe expansion. Insulate exhaust piping wherever it passes through an unheated space with a suitable pipe insulation to prevent condensate freezing.

UNIT	PIPE SIZE	MAX. VENT / AIR INTAKE LENGTH	MIN. VENT / AIR INTAKE LENGTH
UF060D14R	2"	73 Total Equivalent Ft. (e.g., 25 FT. + 6, 90° ELLS)	29 Total Equivalent Ft. (e.g. 5 FT. + 3, 90° ELLS)
UF080D14R	2"	73 Total Equivalent Ft. (e.g., 25FT. + 6, 90° ELLS)	29 Total Equivalent Ft. (e.g. 5 FT. + 3, 90° ELLS)

FIG. 11.9. *Minimum and maximum vent and intake piping lengths.*

11.9.1. CONCENTRIC VENT KIT

A concentric vent kit is available for the UF furnace and will work well in most applications. Choose a location for the vent which is not subject to swirling winds which may cause the products of combustion to be drawn into the intake. Do not locate the concentric vent in any protected corner of the building where prevailing winds may create an eddy thereby trapping the vapor and causing it to be drawn into the intake.

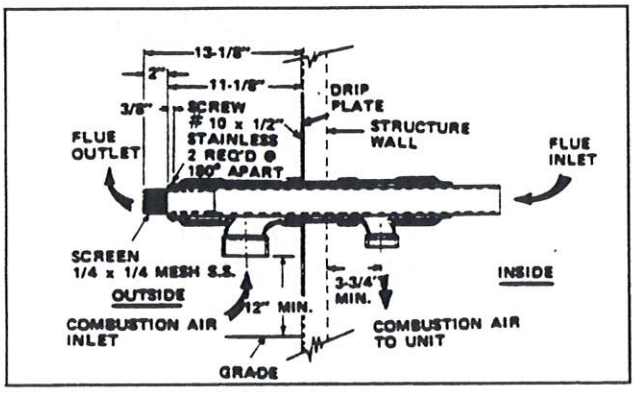


FIG. 11.9.1 *Concentric vent/intake kit.*

11.9.2. SIDEWALL VENTING, SEPARATE INTAKE AND EXHAUST

Separate intake and exhaust piping is permissible provided all code issues are addressed. Keep the intake and exhaust terminations at least 12" apart to avoid recirculation of the flue gases into the combustion air intake. By code, both intake and exhaust terminations must be in the same wind load plane, essentially through the same wall.

11.9.3. VERTICAL VENTING

In new construction, it is often preferable to vent the products of combustion through the roof. By code, combustion air must also be taken from the same roof plane or indoor air for combustion may be used. End vertical exhaust pipes straight up with no fitting on the end of the pipe. Intake termination must include a double elbow arrangement facing downward to prevent rain and snow from entering the intake pipe.

OPTIONAL VENT TERMINATION

If side wall venting is to be used, installation should be done in accordance to the illustration in FIGURE 1.

All dimensions shown in the illustrations MUST be maintained.

INSTALLATION BELOW ANTICIPATED SNOW LEVEL

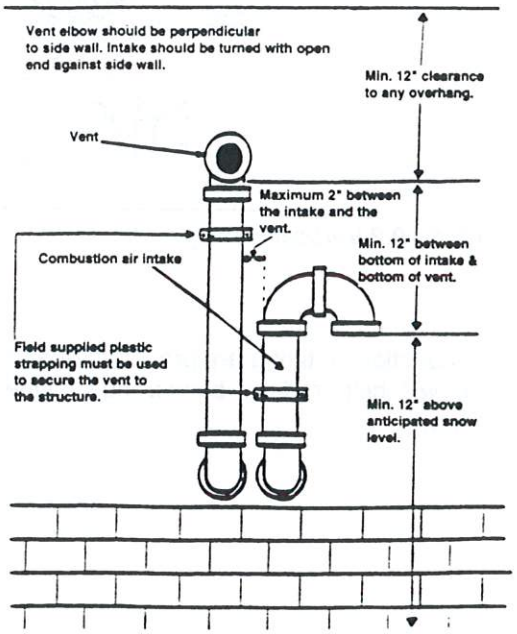
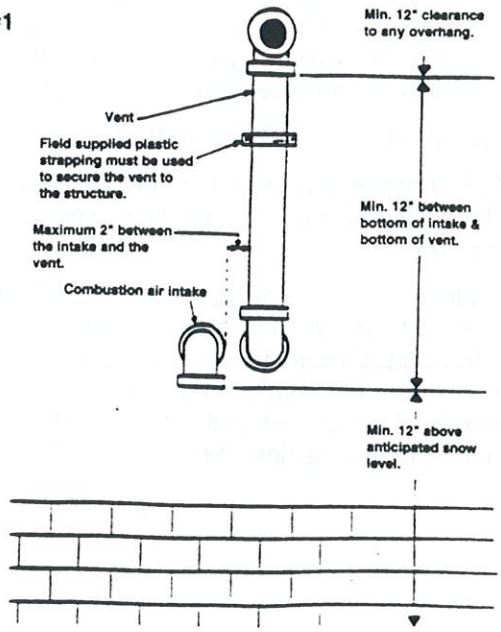

Vent elbow should be perpendicular to side wall. Intake should be turned with open end against side wall.
Min. 12" clearance to any overhang.
Vent
Maximum 2" between the intake and the vent.
Min. 12" between bottom of intake & bottom of vent.
Combustion air intake
Field supplied plastic strapping must be used to secure the vent to the structure.
Min. 12" above anticipated snow level.

FIGURE #1

INSTALLATION ABOVE ANTICIPATED SNOW LEVEL


Min. 12" clearance to any overhang.
Vent
Field supplied plastic strapping must be used to secure the vent to the structure.
Maximum 2" between the intake and the vent.
Min. 12" between bottom of intake & bottom of vent.
Combustion air intake
Min. 12" above anticipated snow level.

ALTERNATIVE SIDE WALL TERMINATION

If for some reason, combustion air and vent piping cannot be routed together, the alternative side wall termination can be carried out to maintain the proper dimensions as illustrated in FIGURE 2.

INSTALLATION BELOW ANTICIPATED SNOW LEVEL

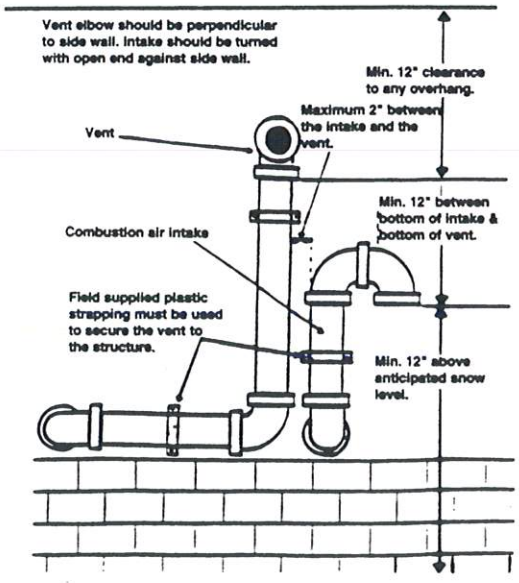

Vent elbow should be perpendicular to side wall. Intake should be turned with open end against side wall.
Min. 12" clearance to any overhang.
Maximum 2" between the intake and the vent.
Vent
Min. 12" between bottom of intake & bottom of vent.
Combustion air intake
Field supplied plastic strapping must be used to secure the vent to the structure.
Min. 12" above anticipated snow level.

FIGURE #2

INSTALLATION ABOVE ANTICIPATED SNOW LEVEL

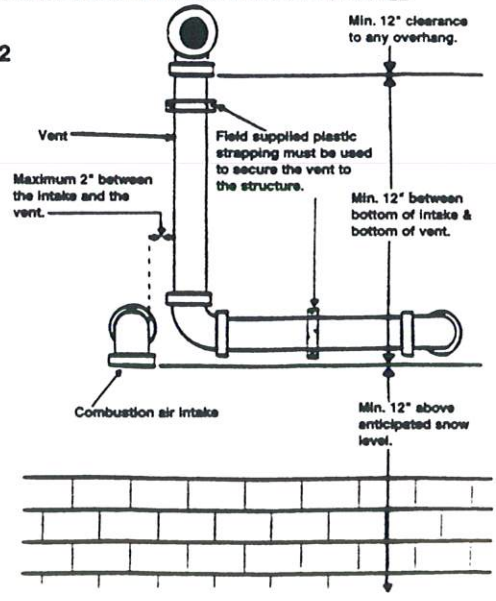

Min. 12" clearance to any overhang.
Vent
Field supplied plastic strapping must be used to secure the vent to the structure.
Maximum 2" between the intake and the vent.
Min. 12" between bottom of intake & bottom of vent.
Combustion air intake
Min. 12" above anticipated snow level.

FIG. 11.9.2. *Sidewall venting.*

Combustion air may also be taken from a well ventilated attic or crawl space. Prevent dust from entering the burner by using the combustion air intake filter provided with the furnace.

Chimneys which are not in use also offer the installer a chaseway through which to vent equipment overhead in retrofit applications. Support the pipe in the chimney to prevent the pipe from sagging or being blown from side-to-side in the chimney by the wind.

11.9.4. INDOOR COMBUSTION AIR

All UF furnaces have been certified for use with indoor air for combustion as an alternative to piping combustion air from outside.

If indoor air for combustion is used with the UF060D14 or UFO80D14R (60,000 and 80,000 BTUH furnace a somewhat higher sound level may be expected in the vicinity of the furnace's air intake. This sound level can be reduced if objectionable by adding an intake muffler as described in SEC. 12.2.4.

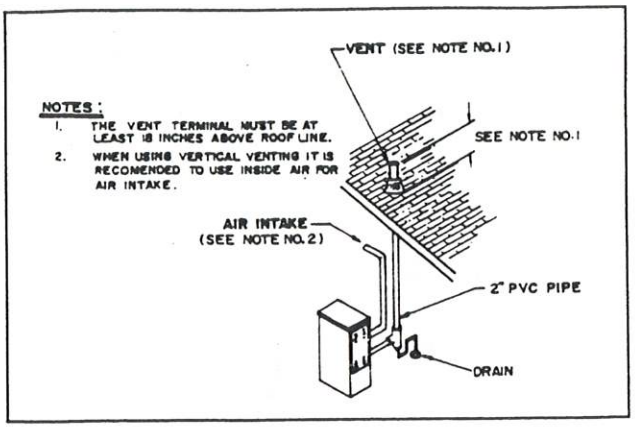

VENT (SEE NOTE NO.1)
NOTES :
1. THE VENT TERMINAL MUST BE AT LEAST 18 INCHES ABOVE ROOF LINE.
2. WHEN USING VERTICAL VENTING IT IS RECOMENDED TO USE INSIDE AIR FOR AIR INTAKE.
SEE NOTE NO.1
AIR INTAKE (SEE NOTE NO.2)
2" PVC PIPE
DRAIN

FIG. 11.9.3 *Vertical venting.*

Combustion air filters are provided for all applications and will help reduce blower noise when installed properly.

12. FURNACE INSTALLATION

The following sections provide specific recommendations and detailed instructions to be followed when installing the UF furnace.

12.1. LOCATING THE FURNACE

Because of minimal requirements for clearances to combustibles and versatile venting requirements of the UF series furnace, location of the furnace is quite flexible. Location consideration is more often dependent on ductwork requirements, either of the existing ductwork, or on the need to locate near the center of the duct runs to provide balanced air distribution.

12.1.1. CLEARANCES TO COMBUSTIBLES

FIG. 12.1.1. indicates the minimum clearances required by national codes. Local codes may differ but most local codes will require that the following clearances established by A.G.A. be the operative guideline. The UF series furnace is designed for zero clearance to combustibles but be sure to allow adequate space for service access to the unit. All units are design certified by A.G.A. for installation on combustible floors and for closet installation. The UF furnace may be set directly on wood floors but not on carpeted or tiled floors.

Clearances to combustibles are minimal--0" back, 1" side, 6" front, and 16" to the top of the furnace--but service access requires slightly more room. See SEC. 12.1.2 for service access clearances.

PVC flue pipes may be run in direct contact with combustibles without any adverse effects. No flue clearance is required.

BACK	FRONT	FLUE	TOP OF FURNACE	SIDE
0	6"	0	16"	1"

TOP OF PLENUM 1 INCH

ACCESSIBILITY CLEARANCE MUST TAKE PRECEDENCE OVER FIRE PROTECTION CLEARANCES.

FIG. 12.1.1. *Clearance to combustibles for UF series furnaces.*

12.1.2. SERVICE CLEARANCES

Virtually all service work on the UF series furnace can be accomplished through the front door of the cabinet. Side clearance is required only for duct and/or piping connections and electrical connections. No rear clearance is necessary. Side clearances are to be a minimum of 8" where access for cleaning and servicing are required.

At least 16" should be allowed above the top panel of the control compartment to allow for the removal of the burner from the boiler assembly. This top panel is removable and makes servicing the unit easier. Do not attach the furnace plenum, ductwork, or accessories to this panel in such a way that would prevent removal.

12.1.3. AMBIENT CONDITIONS

All UF series furnaces are designed for indoor installations. Ambient conditions will affect the selection of heat transfer fluid and the handling of condensate drainage.

When the UF series furnace is installed in a space which is always above a minimum 32°F, water is the recommended heat transfer fluid and no special considerations are needed. Most installations fall into this category. When the potential for the furnace to be subjected to freezing temperatures exists, care must be taken to insure that the heat transfer fluid not be allowed to freeze.

Commercial antifreeze consisting of propylene glycol is available which will insure that the boiler will not be damaged by freezing conditions. Freeze damage is not covered under GlowCore warranty and it is the exclusive responsibility of the installer to assure freeze protection in such cases.

Addition of antifreeze to the system will increase the pumping requirements dramatically for proper operation since antifreeze reduces the heat absorption ability of the heat transfer solution. Increase flow rates through the primary heat exchanger by 10% for solutions containing 20% propylene glycol and increase available head of the pump 23%. 20% is the highest amount of antifreeze recommended for use in the furnace. Freeze protection will be about 17 deg. F at 20%, the point at which the antifreeze will form icy slush but not burst pipes.

EXAMPLE: *A furnace heat exchanger which requires 7 GPM with plain water will need 10% more flow or 7.7 GPM and the head produced by the system will be*

23% higher than the same 7.7 GPM flow of plain water. The UF080D14R heat exchanger produces a head of of about 13'of H_2O at 7.7 GPM with plain water, but with antifreeze figure pump head at 23% more or about 16' of H_2O. An external bronze pump with higher flow and head will be required for the water heater loop since system head and flow will be affected in the same way through the water heater and the internal pump does not produce enough head for that loop.

Additional consideration must be given to the condensate trap and drain piping to insure that freeze up does not occur in the condensate line causing the boiler to shut down on its safety controls. An electric heating cable approved for use on plastic pipe, and pipe insulation must be added to protect the condensate line from freezing.

12.1.4. LEVELING THE FURNACE

UF series furnaces must be leveled from front-to-back and side-to-side to be sure condensate will not collect in the recuperative coil causing exhaust restriction. The recuperative coil is located in a horizontal position allowing condensate to drain to the vent outlet. For more information on the recuperative coil see SEC. 14.4.18. of this manual.

12.1.5. ATTACHING FURNACE TO EXISTING DUCTWORK

UF series furnaces can be installed in virtually any application suitable for standard upflow furnaces. As with any installation, ductwork must be sized to insure adequate air flow for delivery of heated air to the conditioned area. To insure proper installation and design of ductwork GlowCore recommends that ACCA Manual D be followed.

No special consideration is needed to connect the plenum to the furnace beyond normal good practices for proper air flow. Plenum sizes are the same for both the UF060D14R (60,000 BTUH input) and the UF080D14R (80,000 BTUH input): 17-1/2" front-to-back and 19 1/8" side-to-side.

12.1.6. FLEXIBLE DUCT CONNECTORS

Canvas duct connectors are suggested wherever sound isolation is desired. While the UF is normally quieter than many high-efficiency furnaces, in some particularly critical cases the use of flexible duct connectors can help to isolate possible sound transmission from blower motors to ductwork and can also ease installation. See SEC. 12.2.

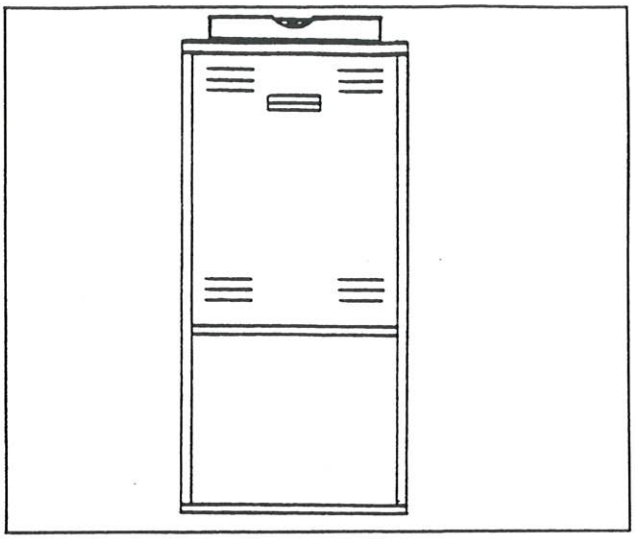


FIG. 12.1.4. *Leveling the furnace to insure proper condensate drainage.*

12.1.7. MOUNTING EXPANSION TANK

Each UF furnace is shipped with a plastic expansion tank and all mounting hardware which must be attached to the plenum or nearby structure at least 6" above the highest point in the system. This tank allows water to expand as heated and prevents the boiler water from overflowing.

The tank is not pressurized but evaporation is largely prevented since the tank is capped. Water levels are to be maintained in this tank at the half full level or slightly above and will need to be checked periodically. Expect the water level in the tank to drop about 1/8" per month typically, so refilling should be required once per year.

Attach the mounting bracket to the plenum or a nearby wall or joist at least six inches above the top panel of the furnace. Attach the plastic expansion tank to the bracket with the plastic tie straps provided. Avoid placing the tank directly above the furnace controls since overflow of the tank could get the controls wet and cause them to malfunction. Mount the tank on the side of the plenum where water spilled during filling or operation will not damage controls.

Run the black 3/8" hose from the bottom of the tank to the copper "Y" inlet/adapter on the internal water circulating pump or to a tee just ahead of the pump if a bronze circulator is used to replace the internal circulator. Attach the hose with the hose clamps provided. Run the 1/4" clear hose from the vent tee at the warm air coil's return outlet to the top of the tank. Allow the 1/4" hose to reach the bottom of the tank through the hole in the top of the tank so the end of the

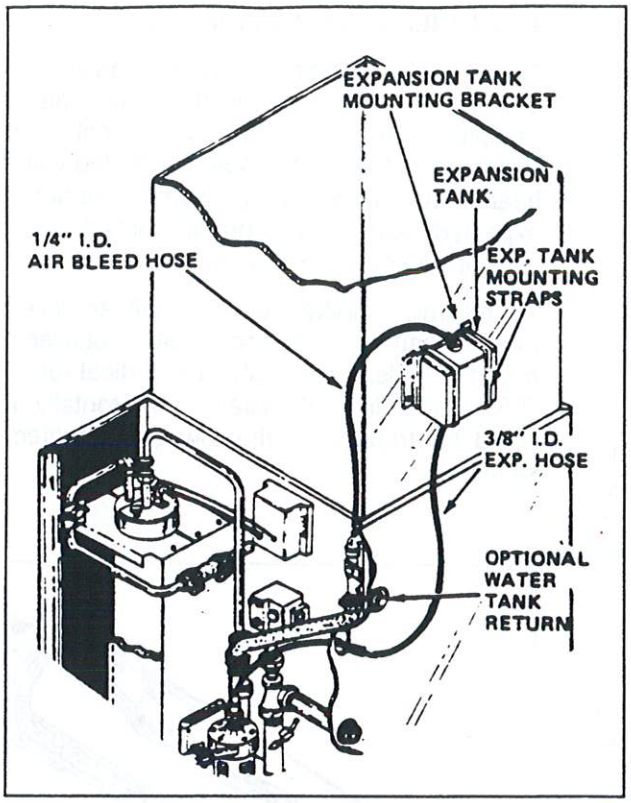


FIG. 12.1.7. *Mounting and location of the expansion tank for the UF furnace. Avoid mounting the tank over the furnace's control cabinet.*

hose is always submerged. Use the small hose clamp provided to attach the clear hose to the adapter provided for the vent tee.

Fill the furnace by pouring water or the appropriate heat exchange fluid into this tank. Shut the gas off, make the R and W terminals, and run the circulating pump to purge all the air from the system before firing the furnace. Operate the diverter valve manually with the pump running to make sure that all piping to the water heater is also filled. Air will naturally rise to the expansion tank and escape. Refilling the tank to the proper level may be necessary after purging air from the system.

Adding an ounce or two of propylene glycol solution, even in cases where freeze protection is not necessary, will help to prevent corrosion within the system and is recommended.

For freeze protection, one quart of propylene glycol will yield about a 30% solution, the maximum recommended.

12.1.8. RETURN AIR PLENUMS

The UF furnace can be installed with return air plenums on either side or on the bottom. Score marks on the sides of the furnace cabinet are provided to indicate where the cabinet should be cut for the proper size and location of the return air plenum. If bottom return is required, the installer will be required to mark and cut the bottom panel.

Return air plenum sizes must be large enough to allow an adequate flow of air through the system without adding excessive restriction.

12.1.9. RETURN AIR FILTERS

A washable fiber filter is supplied with each furnace to be used inside the blower compartment over the return air plenum opening. Be sure to secure the filter with the clips provided to prevent the filter from being drawn into the circulating air blower.

Disposable furnace filters may be used also. Install a filter rack between the return air plenum and the outside of the furnace cabinet.

Filters, if adequately maintained, will prevent a build up of dust and dirt on the warm air coil and will prevent a loss of air flow and subsequent drop in performance.

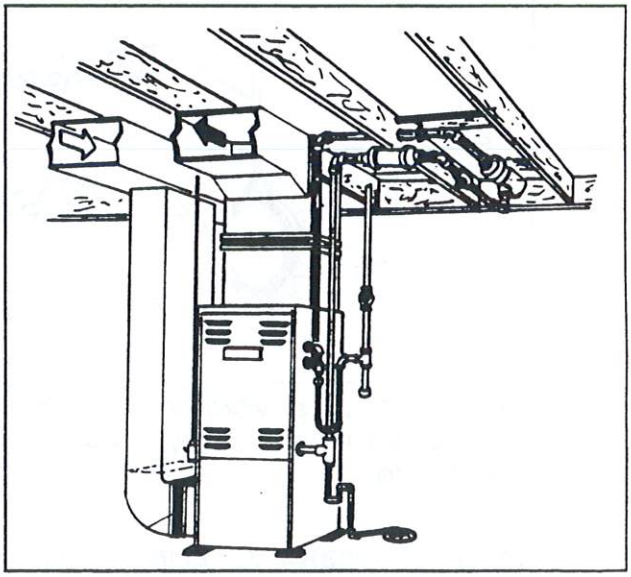


FIG. 12.2. *Options to limit the transmission of sound from the UF series furnace.*

12.2. SOUND ISOLATION

The UF furnace's combustion air blower creates some vibration within the unit. The cabinet has been insulated to limit the transmission of sound to the environment but in some cases it may be necessary to limit sound further. In those cases, the following steps should be taken.

12.2.1. FLEXIBLE GAS CONNECTOR

Rigid steel gas piping may be isolated by means of the A.G.A. listed flexible gas connector provide with all units. Flexible connectors must be entirely in the same room as the furnace and may not penetrate a wall, floor, or ceiling. Install the connector so that it is not stretched out straight but has ample length to allow a u-shaped bend to absorb vibration. Refer to ANSI Z21.24 or ANSI Z21.45 for regulations regarding flexible connectors.

12.2.2. ISOLATING PIPE SUPPORT

Isolation hangers may be used on all gas, vent, and intake piping, and supply and return piping to the water heater to prevent the transmission of sound through the structure to which it is attached. Use rubber pipe insulation between the hanger and the pipe to prevent metal-to-metal contact. Insulate around any pipe which passes through a joist or penetrates a wall or floor.

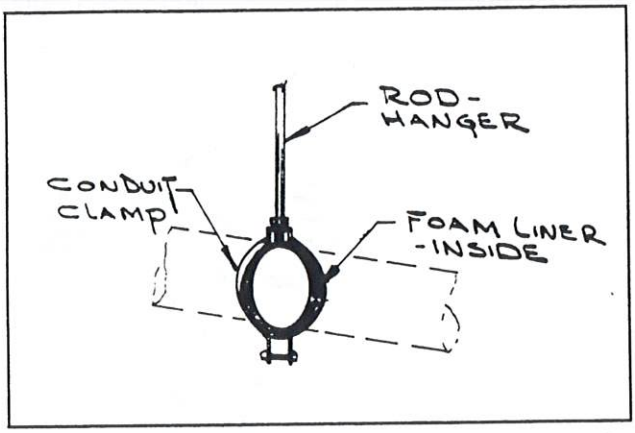


FIG. 12.2.2 *Pipe vibration isolation may be accomplished with rubber pipe insulation between pipe and hanger.*

12.2.3. DUCT VIBRATION ELIMINATORS

Flexible duct hangers may be installed on the supply and return ductwork to prevent transmission of vibrations through the heat distribution system. These are typically made of rubber straps which can be used to suspend the ductwork from structural members.

12.2.4. INLINE INTAKE MUFFLER

The air intake piping of the combustion air blower may emit a resonance associated with the high air velocities which may be objectionable in some instances. If the UF furnace is installed with a water heater, run time during warm weather can be expected. Sound levels present outside the building at the intake may be objectionable.

To minimize intake noise, install an inline intake muffler (part no. CBS, combustion blower silencer) near the boiler, preferably in a vertical run of the 2" PVC intake line. If installed horizontally moisture could be trapped in the low spot created by the silencer.

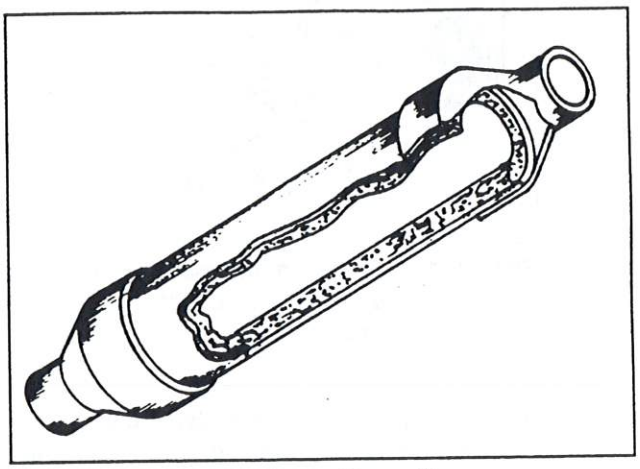


FIG. 12.2.4. *Inline intake muffler option.*

12.3. VENT/INTAKE/CONDENSATE PIPING INSTALLATION

The UF060D14R and the UF080D14R are listed as direct vent heating devices and are piped directly to the outside for combustion air in most installations. Both are approved for use with indoor air if necessary. See SEC. 12.3.6. for information on indoor air for combustion. FIG. 11.9. lists minimum and maximum vent lengths for UF series furnaces.

12.3.1. MATERIALS OF CONSTRUCTION

The approved materials of construction are schedule 40 PVC pipe in the sizes and lengths listed in the accompanying charts. CPVC pipe may also be used but is more expensive than PVC pipe.

12.3.2. ALTERNATE MATERIALS OF CONSTRUCTION

Other materials must be code approved for the type of application in which they are employed. High tempera-ture plastic pipes such as Hart & Cooley's "Ultravent" and Plexco's "Plexvent" are acceptable if local codes permit and size and length of piping are consistent with the chart (FIG. 11.9).

12.3.3. ASSEMBLY PRACTICES

Remove all plastic debris and burrs when installing intake piping. Plastic filings caused by cutting the plastic pipe must not be allowed to be drawn into the combustion air blower. Debris from the assembly process will jam the blower impeller and cause blower failure because of close tolerances in the combustion air blower. *Blower failure which is determined to be caused by plastic filings in the blower will not be covered under warranty.*

All vent pipe joints must be made secure with PVC solvent cement and checked for tightness. Flue gas vent pipe connections should be checked with soap and water solution with the combustion air blower running and the vent blocked. A no-hub fitting may be used where the air intake filter is connected to the furnace for easy removal should service to the combustion air blower be required.

In the concentric vent kit, do not cement the pipe to the reamed reducers which center the exhaust pipe to allow for expansion of the tubing.

Slope the vent line back to the condensate tee at a rate of 1/4" per foot of horizontal run. Support plastic pipe every two to three feet.

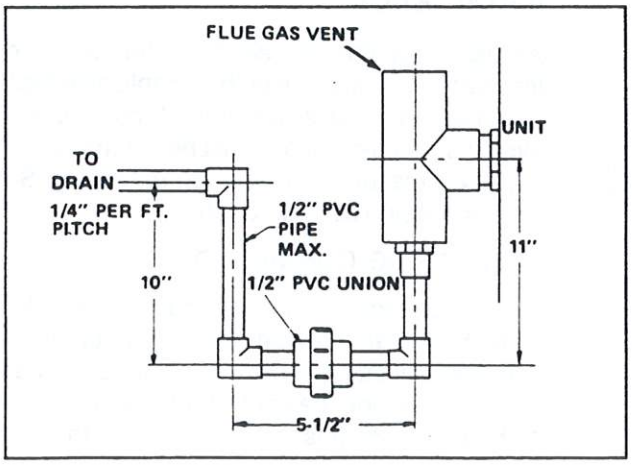


FIG. 12.3.4. *Condensate trap configuration.*

12.3.4. CONDENSATE DRAINAGE

Condensate lines may be either 1/2" PVC or CPVC. A plastic union is recommended in the 1/2" condensate drain trap to allow the removal of any sediment in the trap and to facilitate some service and troubleshooting procedures. Slope the condensate drain line toward the floor drain at a rate of 1/4" per foot of horizontal run. A condensate pump approved for use with condensing gas-fired equipment may be used if no floor drain is available.

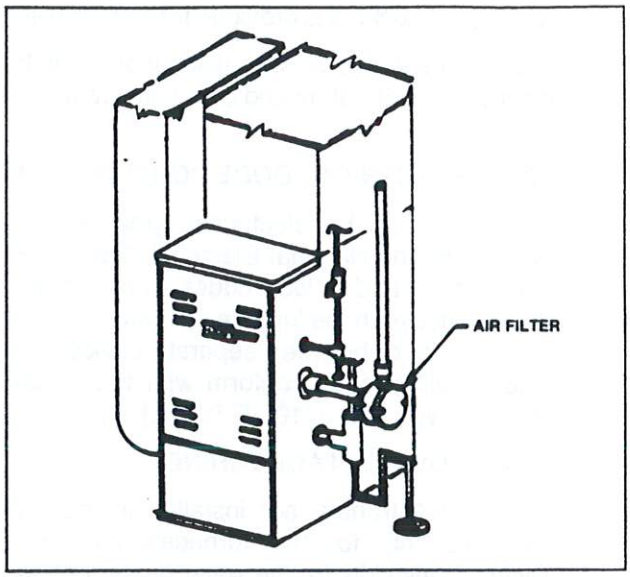


FIG. 12.3.5. *Combustion air filter option for indoor or outdoor installation.*

To prevent the escape of exhaust gas through the condensate drain line, a trap must be installed to maintain a water seal at least 10" in depth. See FIG. 12.3.4. for trap dimensions.

12.3.5. COMBUSTION AIR FILTER

Combustion air filters are provided with each UF furnace (p/n 185002, old p/n 704-5370, replacement element p/n 1850001, old p/n 704-5369) for all installations. The combustion air filter will prevent plugging of the burner caused by dirt being trapped in the burner's outer mesh covering. The filter element supplied with the filter (p/n 1850001, old p/n 704-5369) is not designed to be weather resistant and is approved for indoor use only.

12.3.6. INDOOR AIR FOR COMBUSTION

Provide adequate ventilation for the furnace room to provide combustion air if indoor air is used for combustion. National Fuel Gas Code (ANSI Z223.1, SEC. 5.3.3) requires a minimum of 1 square inch per

4,000 BTU of input of free area when air is drawn directly from outside to the furnace room. Note that minimum vent/intake lengths must still be observed for proper operation.

12.4. ELECTRICAL CONNECTIONS

See FIG. 11.8. for the electrical ratings for the various sizes of UF furnaces. Design a separately fused, permanently live circuit of proper ampacity for the furnace, booster pump, and accessories. Install a junction box on the outside of the furnace cabinet where the knockout is provided for electrical service.

Provide a suitable service disconnect switch on the junction box for safety and convenience when servicing the unit.

12.4.1. ELECTRICAL CODE CONSIDERATIONS

Furnaces must be electrically grounded in accordance with the National Electrical Code ANSI/NFPA No. 70-1987 and all local codes. Wiring to be done in the field between the furnace and devices not a part of the furnace, or between separate devices which are field installed, shall conform with temperature limitation for type T wire (194°F. [90°C.] rise).

12.4.2. LOW VOLTAGE WIRING

The 40 VA transformer installed in the furnace is intended only for the furnace's internal control. Diverter valve kits for the water heater option include a separate transformer to power the valve's actuator. If a separate 24 vac circuit is required for accessories, a separate junction box should be installed to mount the transformer.

Thermostat and low voltage control wiring to controls such as relays may be 18 or 20 ga. copper thermostat wire.

Furnaces built since serial number 895300000 include a low voltage terminal strip mounted to the right side of the furnace cabinet which includes the pre-wired diverter valve connections and terminals for heating and cooling control wiring. These strips can be wired using spade connectors or screw terminals.

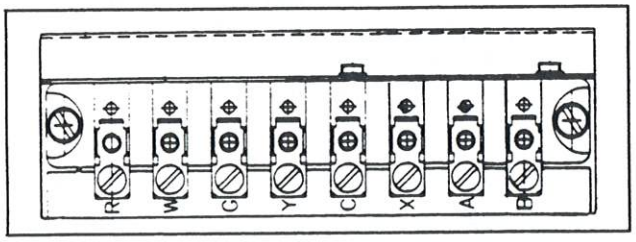


FIG. 12.4.2 *Low voltage terminal strip provided for control wiring.*

12.5. GAS PIPING

All gas piping for UF series furnaces must comply with National Fuel Gas codes and ANSI standard Z223.1 and the requirements of local utilities. Refer to TABLE 6 or 7 for capacities of gas piping.

Install an approved shutoff valve, ground joint union, and drip leg as indicated in FIG. 11.7.

Be certain to install a pipe of large enough diameter to minimize pressure drop in the line when the furnace is running. A gas line which is too small will show the proper pressure when the furnace is not running but pressures will drop dramatically when the furnace's gas valve opens and may create problems because the pressure regulator cannot pass enough gas for the burner to fire within the necessary range.

12.5.1. MINIMUM/MAXIMUM NATURAL GAS PRESSURES

Natural gas pressures ahead of the gas valve must be maintained at 7.0" w.c.(minimum 5.0", maximum 10.0" w.c.) while the furnace is running.

12.5.2. MINIMUM/MAXIMUM LP GAS PRESSURES

LP gas pressures must be maintained at 11.0" w.c. (maximum 13.0" w.c.) ahead of the gas valve while the furnace is running.

Gas pressures above or below these levels will lead to problems associated with the gas valve's internal pressure regulator.

12.6. WT SERIES WATER HEATER INSTALLATION

All piping for the WT series water heater must be installed in accordance with all applicable local, state, and national codes for forced hot water heating systems. Consideration must be given to pipe capacities and pressure drop through the piping. See SEC. 11.5. for design considerations.

12.6.1. PIPING CONNECTION

Piping connections for the indirect-fired WT series water heater are provided on the UF furnace. A boiler water supply outlet is provided just below the diverter valve body inside the control compartment. A plugged 1" female adapter is installed for both the supply and

return piping to the furnace. The return inlet is on the right side of the cabinet and enters just below the fan switch in the upper right hand corner of the furnace control cabinet. Use ground joint unions in the water piping where appropriate to facilitate subsequent service procedures.

12.6.2. BOOSTER PUMP INSTALLATION

If the water heater is placed any distance from the UF furnace, additional piping will cause additional pressure drop in the system and will in many cases require the use of a booster pump to assure adequate water flow for efficient and noise-free operation.

Install a bronze circulator since this is an open system and corrosion will occur if cast iron pumps are used. Be sure that the pumping characteristics are ample for the application.

Install a low voltage relay to start the pump anytime the tank thermostat calls for heat. See SEC. 11.5.6.

12.6.3. DIVERTER VALVE INSTALLATION

The UF furnace includes the diverter valve already installed in the system and internally wired. Only the low voltage tank thermostat needs to be field wired.

The valve operator has four wires, two black which power the diverter valve's 24 volt motor, and two blue which are prewired into the valve actuator's end switch and attached to the R-W terminals to start the furnace. See SEC. 11.5.8.

12.6.4. BLOWER CUTOUT RELAY

INSTALLATION

Included in the furnace wiring is a low-voltage relay which is used to prevent the operation of the circulating air blower during water heating cycles. Return water from the tank enters the furnace just below the fan switch and heat migrates through the copper fittings and will cause the blower to run even though there is no hot water in the warm air coil.

Operation of the blower on the heating speed tap is prevented by the blower cutout relay unless the relay is powered by the room thermostat. Blower operation for air conditioning is unaffected by the relay since the contacts in the relay only break the heating speed tap circuit, not the high speed air conditioning tap. Both air conditioning and water heating may occur simultaneously. Heating and water heating can not occur simultaneously since all of the furnace's output is given over to water heating on a call from the tank thermostat so fan operation must be prevented. See SEC. 11.5.7.

12.7. AIR CLEANERS

Air cleaners can improve the indoor environment by removing airborne dust particles from the environmental air as it passes through the return air ductwork. Homes stay cleaner and more dust-free and the air is healthier for individuals with respiratory problems.

12.7.1. MEDIA TYPE AIR FILTERS

Media type filters use a paper or fiber filter media which traps dust particles as the air passes through the filter. Media filters are installed in the return air plenum and add restriction to air flow in the system. Be sure to account for this friction loss when designing ductwork.

12.7.2. ELECTRONIC AIR CLEANERS

Electronic air cleaners trap dust particles by imparting a static electric charge to the particles and then trapping the particles on an electrically charged plate of the opposite polarity.

Electronic air filters are normally connected to the furnace so that the air cleaner is energized each time the circulating air blower runs. Follow the air cleaner manufacturer's instructions for installation on a UF furnace.

12.8. HUMIDIFIERS

Humidifiers increase comfort levels by adding moisture to excessively dry winter air within a heated space by means of an evaporative process in the supply air stream. A number of different types of humidifiers, both electric and non-electric, are available. Follow the humidifier manufacturer's instructions when installing humidifiers.

12.9. AIR CONDITIONING

Air conditioning can be added to the UF furnace to give total environmental control by cooling and dehumidifying the environmental air when needed. UF furnaces are equipped to accept air conditioning units up 3‹ tons at a .5" w.c. static pressure at 400 cubic feet per minute air flow per ton (4 tons at 350 CFM/ton at .5" w.c.).

To properly air condition a structure, do not oversize the air conditioning unit. Oversized units will cool the air rapidly but will not dehumidify the air satisfactorily and the evaporator coil may freeze over under such circumstances and prevent air flow completely, thus leading to premature compressor failure.

Undersized units will give good dehumidification and occupants may well be more comfortable at higher temperatures but desired temperatures within the structure may not be attainable.

12.9.1. INSTALLING EVAPORATOR COIL

The evaporator is installed in the supply plenum as with most upflow systems. Follow the air conditioning manufacturer's installation instructions.

The installer may wish to allow for an inspection door to the warm air coil for subsequent access to the coil. Be sure to install a condensate drain pan and drain the air conditioner's condensate to a floor drain or suitable condensate pump. Do not tie the air conditioner's condensate drain into the furnace condensate drain ahead of the furnace condensate trap. The condensate drains may be tied together after the traps and the same condensate pump or drain line may handle both.

12.9.2. COMPRESSOR CONTACTOR RELAY

A relay inside the outdoor condensing unit's cabinet operates off the low voltage thermostat circuit and makes the 240 volt AC circuit to start the compressor. The relay must be a double pole, single-throw relay with a 24 volt AC coil to operate the condenser.

13. START-UP AND CHECKOUT OF SYSTEM

After the installation is complete, the system must be filled with clean water and the gas piping must be purged of air and tested for leaks with a solution of soapy water.

A few simple steps to assure proper operation are recommended on start up. With the furnace running clock the gas meter (See SEC. 13.3.) or perform a carbon dioxide exhaust gas analysis (See SEC. 13.5.1.) to determine that input is correct, check plenum air temperature rise (See SEC. 13.5.3.) to determine if air flow is adequate, and run the furnace through several firing sequences to determine that ignition is instantaneous when the gas valve opens.

Furnaces converted to operate on LP gas must be checked for proper carbon dioxide readings to insure efficient, trouble-free operation. See SEC. 13.5.

13.1. FILLING THE FURNACE WITH HEAT EXCHANGE FLUID

All UF furnaces are fired on the production line for quality assurance. A heat exchanger fluid including propylene glycol is used to prevent any fluid left in the furnace from freezing while in the warehouse or in transit. The residual amount of glycol left in the system is calculated to be left in the fluid when the furnace is initially filled and will help condition the heat exchange fluid and give a good wetting action for all heat exchange surfaces and to provide lubrication to the circulator pump.

13.2. FIRING THE FURNACE

UF furnaces are test fired on the production line and the input is set to proper levels using flow meters. If the furnace is supplied with the proper gas pressure, no adjustment should be necessary to achieve proper firing. Combustion analysis is always the best way to insure proper setup. 13.3.) to be certain that inputs are correct and should be performed on every startup.

Complete the circuit from terminal R to W by turning up the room thermostat or by installing a jumper wire between R and W. Make sure the gas is turned on and 125 vac current is available to the furnace. The combustion air blower should start and the unit should begin its firing sequence. With the top of the furnace cabinet removed the flame may be observed through the sight glass in the burner mounting plate. The unit should fire and stay lit.

If the burner does not light immediately the ignition control may go into lockout. If this happens reset the control by interrupting power to the unit for 30 seconds, then retry. If the gas line has not been completely purged of air it may be necessary to make several tries until the burner stays lit.

If after several tries the burner does not light or will not stay lit, it may be necessary to adjust the gas pressure downstream from the gas valve by adjusting the gas valve's built-in pressure regulator. See SEC. 13.2.1.

If the burner still does not light after setting the gas pressures to the listed specifications, increase the gas pressure by turning the regulator about one half turn clockwise, replace regulator cap, and retry. Repeat this process until the burner lights. Make sure that the igniter gaps are set properly. See SEC. 15.1.3.

13.2.1. SETTING GAS PRESSURES

To check outlet gas pressure, remove the allen screw on the left side of the gas valve (the side toward the boiler's heat exchanger) and connect a U-tube manometer. Set the gas pressure to the proper setting for the gas being used: 2.5 " w.c. for natural gas and 8.5" w.c. for LP gas. Setting gas pressure as above is always necessary when performing the LP gas conversion. See SEC. 13.4. for information on converting the furnace to use LP gas.

To set outlet gas pressures, locate and remove the screw cap covering the gas valve's pressure regulator adjusting screw. Turn the plastic pressure regulator screw in (clockwise) to increase gas pressure, and out (counterclockwise) to decrease gas pressure. Replace the screw cap before reading pressures on the manometer.

Setting the gas pressures as above will give the proper coarse adjustment and a starting point from which to fine tune the burner. Fine tuning the burner requires the use of a combustion analyzer as described in SEC. SEC. 13.5.1.

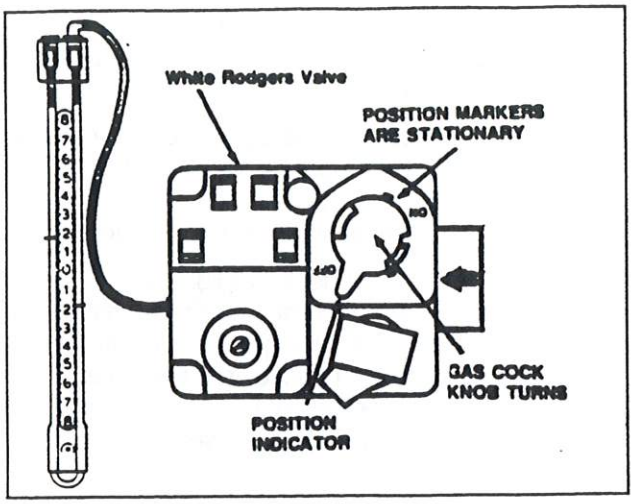


FIG. 13.2.1. *Gas valve showing pressure regulator adjustment and gas pressure test port.*

13.3. CLOCKING THE GAS METER--NATURAL GAS

After the furnace has been started and with no other appliances using gas, clock the gas meter to be certain that the unit is running at the proper gas input. See FIG. 13.3. to determine the cubic feet of gas passing through the meter and determine the input in BTU per hour. Input must be within plus or minus 3% of the rated input.

Turn off the gas supply to all other appliances except the furnace. With the furnace operating, time the one or two foot dial on the meter for one revolution. Time two revolutions if using a half foot dial. Use the appropriate column in FIG. 13.3. to determine the input to the burner. Adjust input at the gas valve regulator. Screw spring cap in (clockwise) to increase input, out (counterclockwise) to decrease input.

EXAMPLE: *If the natural gas locally available contains 1,000 BTU per cubic foot and one revolution of the one cubic foot dial requires 40 seconds, then*

$$\frac{1{,}000 \text{ BTUH/cu.ft.} \times 3600 \text{ seconds per hour}}{45 \text{ seconds per cubic foot}}$$

$$= 80{,}000 \text{ BTU per hour}$$

See FIG. 13.3.0 for a direct read out of the number of cubic feet per hour based on the number of seconds required for one revolution of various dial sizes. To convert to BTU multiply the number of cubic feet by the BTU value per cubic foot of natural gas locally available, usually 1,000 BTU per cubic foot. At higher altitudes natural gas is often derated to compensate for the less dense air. Check with the local gas utility for the proper value to use.

If the furnace is equipped with the original orifices input within the proper range will yield carbon dioxide readings within the range of 8.5 to 9% for natural gas. See SEC. 13.5. for information regarding flue gas analysis and carbon dioxide levels.

13.4. LP GAS CONVERSION

All UF furnaces are built and shipped as natural gas fired units unless otherwise specified. Field conversion kits are available to convert UF series furnaces to use LP gas.

SECONDS FOR ONE REVOLUTION	SIZE OF TEST DIAL		
	1 CU. FT.	2 CU. FT.	3 CU. FT.
10	360	720	1800
11	327	655	1636
12	300	600	1500
13	277	555	1385
14	257	515	1286
15	240	480	1200
16	225	450	1125
17	212	424	1059
18	200	400	1000
19	189	379	974
20	180	360	947
21	171	343	857
22	164	327	818
23	157	313	788
24	150	300	750
25	144	288	720
26	138	277	692
27	133	267	667

SECONDS FOR ONE REVOLUTION	SIZE OF TEST DIAL		
	1 CU. FT.	2 CU. FT.	3 CU. FT.
28	129	257	643
29	124	248	621
30	120	240	600
31	116	231	581
32	113	225	563
33	109	218	545
34	106	212	529
35	103	206	514
36	100	200	500
37	97	195	486
38	95	189	479
39	92	185	462
40	90	180	450
41	—	176	439
42	86	172	429
43	—	167	419
44	82	164	409
45	80	160	400

SECONDS FOR ONE REVOLUTION	SIZE OF TEST DIAL		
	1 CU. FT.	2 CU. FT.	3 CU. FT.
46	78	157	391
47	—	153	383
48	75	150	375
49	—	147	367
50	72	144	360
—	—	—	—
52	69	138	346
54	67	133	333
56	64	129	321
58	62	124	310
60	60	120	300
—	—	—	—

FIG. 13.3. *Gas meter timing chart. Convert seconds per revolution of test dial to cubic feet of gas for furnace input measurement.*

CONVERSION TO LP GAS MUST ONLY BE PERFORMED BY QUALIFIED SERVICE PERSONNEL. THE PROCEDURE MUST INCLUDE COMBUSTION ANALYSIS FOR SAFE AND EFFICIENT OPERATION OF THE EQUIPMENT.

WARNING

13.4.1. LP GAS CONVERSION OF UF080D14R ONLY

The discharge air orifice is not changed on any sea level conversion with the exception of the UF080D14R (80,000 BTUH furnace. When converting the UF080D14R disconnect the gas/air supply tube from the combustion air blower to the burner. Unscrew the nipple from the combustion air blower outlet, unscrew the black iron bell reducer from the nipple, and remove the aluminum orifice which is pressed into the end ofthe nipple by gently tapping the orifice out of the nipple. Use a wooden stick which will fit inside a 1-1/4" nipple to drive the orifice out of the pipe. Discard the existing discharge orifice and replace with the proper orifice by gently tapping the new orifice into the reamed end of the nipple. Protect the new orifice from damage by using a wooden block when tapping the new orifice into place.

Reinstall the nipple with the discharge orifice in the top end of the nipple, the black iron bell reducer, and the compression fitting adapter.

Reinstall the gas/air tube between the nipple and the burner. Be sure threads are gas-tight by checking the fittings with a soapy water solution while the combustion air blower is running. Proceed as described in SEC. 13.4.2.

13.4.2. LP GAS CONVERSION OF UF060D14R ONLY

With the gas supply turned off, unscrew the ground joint union below the gas valve and remove the natural gas orifice located between the halves of the union and replace with the proper LP orifice for the unit. Discard unused orifices.

The discharge air orifice is not changed when converting the UF060D14R furnace. See SEC. 13.4.1.

On all LP conversions proceed by removing the slotted aluminum screw cap covering the gas valve's pressure regulator and remove the plastic spring cap found behind the regulator cap. Remove the natural gas regulator spring and replace with the new spring contained in the LP conversion kit. Discard the natural gas spring. Replace the plastic spring cap and screw in approximately 1/4". This spring changes the range of pressures attainable with the pressure regulator to the range necessary for LP gas.

Check gas pressures with a U-tube manometer connected to the inlet side of the gas valve. Inlet pressures must be between 11.0 and 13.0" w.c. Check inlet pressures to the gas valve by removing the 1/8" pipe plug on the right (inlet) side of the gas valve and connecting the manometer to this port.

With the furnace running and the gas valve open check the gas valve outlet pressure with a manometer connected to the 1/8" port on the left (outlet) side of the gas valve. Set LP gas pressure downstream of the gas valve at 8.5" w.c. with the regulator cap in place (or cover the regulator port with a finger to take the reading). Pressure will differ depending on whether or not the cap is in place or the port is covered. Set the gas pressure about .5" w.c. higher with the port open to achieve the proper setting when the cap is reinstalled. Turn the regulator spring cap clockwise to increase outlet pressure, counterclockwise to decrease outlet pressure.

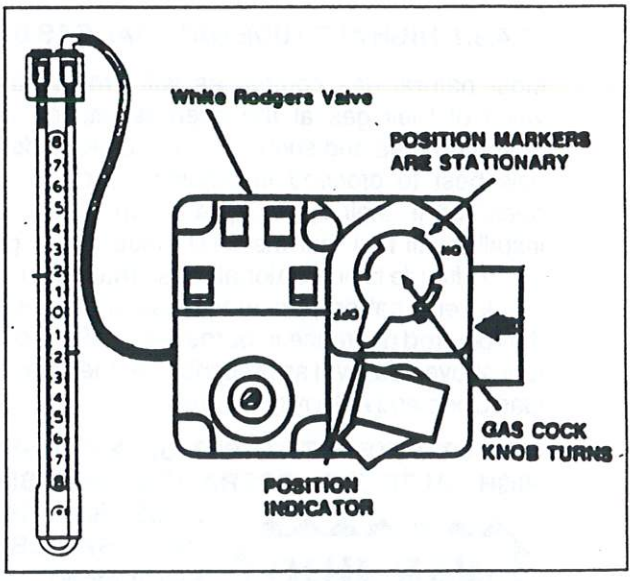


FIG. 13.4.2. *Checking gas pressures with a U-tube manometer.*

Setting LP gas pressure to 8.5" w.c. will give a starting point for initial firing. If the fuel lines are completely purged of air and the unit does not immediately light, set the gas pressure higher in steps of one-half turn of the pressure regulator spring cap screw until the

burner ignites. Replace the gas valve's regulator cap after each adjustment before firing the burner. Remember to reset the ignition control if the unit goes into a lockout condition because of flame failure. See SEC. 14.4.9. for additional information regarding the ignition control.

Fine tune the burner by checking the carbon dioxide content of the flue gas with an appropriate combustion analyzer (SEC. 13.5.). Carbon dioxide readings must fall between 9.7% and 10.7% for proper operation on LP gas. Carbon dioxide testing is essential to the proper operation of the furnace on LP gas. Failure to set carbon dioxide levels will likely result in delayed ignition and/or failure to light resulting in call backs for the installer.

13.4.3. HIGH ALTITUDE CONVERSION

Operation of furnaces at high altitudes, that is over 3,000 feet above sea level, requires a reduction in fuel input because of the reduced availability of oxygen in the less dense air. At lower barometric pressures each cubic foot of air contains less oxygen, and fuel input must be reduced accordingly to prevent a too-rich fuel-air mixture and the subsequent production of high levels of carbon monoxide and inefficient combustion.

13.4.3.1. HIGH ALTITUDE NATURAL GAS UNITS

Most natural gas companies will provide the BTU value of their gas at the average altitude for their operating area and should be consulted to determine how best to proceed in adjusting for high altitude operation in their operating area. In most cases the installer will find that the BTU value of the gas at a given altitude is proportionally less than natural gas at sea level. That proportion will usually correspond to the required decrease in burner input of 4% per 1,000 feet above sea level as prescribed in the National Fuel Gas Code and AGA regulations.

DO NOT ATTEMPT TO SET UP A BURNER FOR HIGH ALTITUDE OPERATION UNLESS YOU POSSESS THE PROPER SKILLS AND EQUIPMENT TO DO COMBUSTION ANALYSIS.

The final answer as to the proper operation of the unit will always be obtained through combustion analysis: if carbon dioxide and carbon monoxide levels are within the appropriate ranges, the unit is firing properly. If the BTU value of the gas provided by the local utility is intentionally increased then, and only then, will a decrease in orifice size be required when installing a natural gas unit at high altitudes.

When installing GlowCore furnaces at high altitude,change the combustion air pressure switch as indicated and attempt to fire the unit with the factory-installed orifices called for in the following table for sea level operation. Gas-air ratios will probably be correct for optimum combustion with the sea level natural gas orifices as factory equipped under normal circumstances where natural gas BTU values are proportionally less.

Air and discharge orifices will not be changed. The table gives the proper combustion air pressure switch to use at various altitudes. These switches will have to be changed to obtain proper safety control relative to the combustion air flow.

If the unit does not immediately fire with the sea level orifices after fuel lines have been purged of air, and firing cannot be obtained by adjusting the gas pressure regulator in the gas valve it will be necessary to change the gas orifice, probably to the next smaller, or in some cases the next larger orifice.

When the unit fires, perform a carbon dioxide combustion gas analysis and set the CO_2 level to 8.5 to 9.0% for a natural gas fired unit. Increase gas pressure to increase CO_2 and decrease gas pressure to decrease CO_2. Be sure that an increase in pressure, obtained by turning the gas pressure regulator screw clockwise, increases CO_2 or that a decrease in pressure, obtained by turning the gas pressure regulating screw out or counterclockwise, produces a decrease in CO_2 levels. If the CO_2 levels respond in this way, the unit is firing properly. Note that if the unit is grossly over-fired for the amount of oxygen available the same CO_2 readings may be achieved, but changes in gas pressure will have the opposite effect on the CO_2 level: increases in gas pressure will produce a decrease in CO_2. The sea level orifices will produce firing rates close to the optimum rate.

Following the above procedure will lead to combustion which is at a lesser BTU per hour input than at sea level to compensate for the reduced oxygen availability at high altitude. *The unit will operate at a reduced input although the gas meter will likely indicate the same amount of cubic feet per hour of gas as at sea level.* Since the same volume of gas at high altitude will contain less BTUs, the firing rate will be decreased. The final input in BTUs will be less than sea level input by about 4% per thousand feet above sea level.

In most cases no change will be needed to operate GlowCore boilers and furnaces on natural gas at high altitudes. Only combustion testing and a slight adjustment of the gas valve pressure regulator may be necessary. Orifice change, if necessary, will be indicated by combustion testing and an inability to achieve proper CO_2 levels and will usually require a change of only one orifice size smaller or larger. Choose an orifice which will allow the gas pressure regulator screw to be set at about the middle of its travel, that is with an outlet gas pressure of 2.5" to 2.7" w.c. for natural gas, while permitting proper adjustment of the CO_2 level.

EXAMPLE FOR NATURAL GAS: *Upon installation of a GlowCore unit at high altitude on natural gas of unknown BTU value, attempt to fire the unit with the orifices provided in the unit. If the unit fires, check and adjust CO_2 until the proper level (8.5-9.0% CO_2) is achieved.*

If the unit will not fire, change to the next smaller orifice and attempt to fire again. If the unit still will not fire, try the next larger orifice.

If the unit will not fire with any of these three orifices contact the local gas company for the BTU value of the gas, then check with your GlowCore distributor or the GlowCore service department for the proper orifice to use based on the gas BTU value. When the unit fires, perform a combustion analysis as above and adjust to proper CO_2 level.

Carbon monoxide levels will be acceptable (below 400 parts per million) if an increase in gas pressure produces an increase in carbon dioxide (CO_2) levels, or a decrease in gas pressure produces a decrease in CO_2 levels.

13.4.3.2. HIGH ALTITUDE LP GAS UNITS

LP gas has a consistent BTU value even at high altitudes because it is much denser than natural gas and because it is delivered as a liquid to the end user's site. On units to be fired with LP gas at high altitude, replace the factory installed orifice with the orifice called for in the chart for the given altitude and proceed to fire the unit as above. Assure proper combustion by performing CO_2 analysis as described above. CO_2 levels for LP fired units must fall between 9.7 and 10.7%.

EXAMPLE FOR PROPANE GAS: *Install the propane conversion kit as directed in the kit's instructions. Change the gas orifice as indicated in the chart for the given altitude, the gas valve pressure regulator spring, and the combustion air pressure switch, and attempt to fire the unit. If the unit fires, check and adjust CO_2 to between 9.7% and 10.7%.*

If the unit will not fire after purging the gas line and adjusting gas pressure, change to the next smaller orifice and retry. If the unit still does not fire, install the next larger orifice and try again.

Carbon monoxide levels will be acceptable if an increase in gas pressure produces an increase in carbon dioxide (CO_2) levels, or a decrease in gas pressure produces a decrease in CO_2 levels. If CO_2 levels decrease with and increase in gas pressure or if CO_2 levels increase with a decrease in gas pressure, the unit is too fuel rich and grossly overfired and a reduction in orifice size is mandatory to correct this situation.

The installation is complete when the unit fires at the proper CO_2 level for propane (9.7-10.7% CO_2) and adjustment of the gas pressure produces results as described above.

13.5. FLUE GAS ANALYSIS FOR OPTIMUM OPERATION

Flue gas analysis will provide precise information regarding the operation of the UF series furnace. All propane and high altitude installations must be checked for proper fuel/air mixture and annual tune-up of the furnace will be appreciably more reliable if combustion analysis is performed after cleaning the burner.

13.5.1. CHECKING CARBON DIOXIDE LEVELS

Carbon dioxide is a colorless, odorless gas produced by all combustion processes. When the UF series furnace is operating properly carbon dioxide levels will be between 8.5 and 9.0% carbon dioxide for natural gas and between 9.7 and 10.7% carbon dioxide for LP gas.

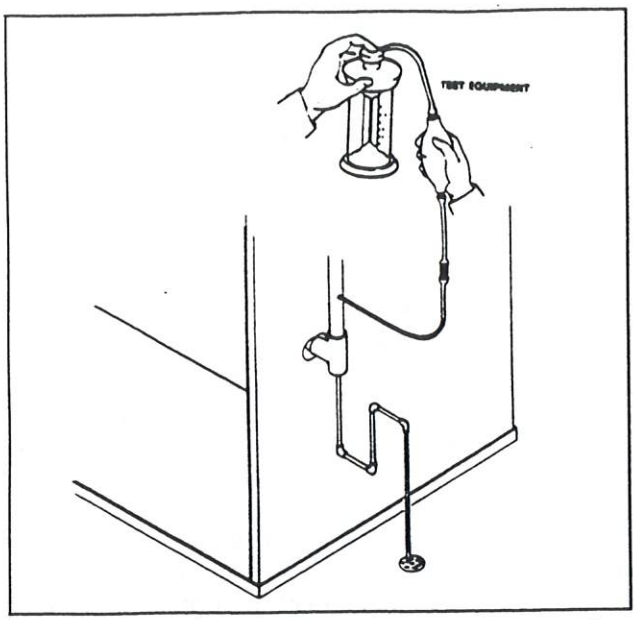


FIG. 13.5.1. *Testing for carbon dioxide or carbon monoxide levels in flue gases.*

To measure carbon dioxide levels in the UF series furnace drill a 1/4" hole (or the appropriate size hole for the test probe) in the flue piping near the furnace's flue outlet. Insert the probe in the flue pipe and sample the gases as instructed in the test equipment's instructions. See FIG. 13.5.1.

To raise carbon dioxide levels increase the gas input by turning the plastic screw under the regulator cap clockwise. Lower carbon dioxide levels by screwing the regulator adjusting screw counterclockwise.

If carbon dioxide levels do not respond to adjustments as listed above the burner is probably grossly overfired. If, for instance, a clockwise adjustment to the gas regulator produces a decrease in carbon dioxide the burner is too fuel-rich and not enough oxygen is present for proper and complete combustion.

SEAL THE FLUE PIPE TEST PORT AFTER PERFORMING COMBUSTION ANALYSIS. FLUE GASES MUST NOT BE ALLOWED TO CONTAMINATE THE INDOOR AIR OF A STRUCTURE.

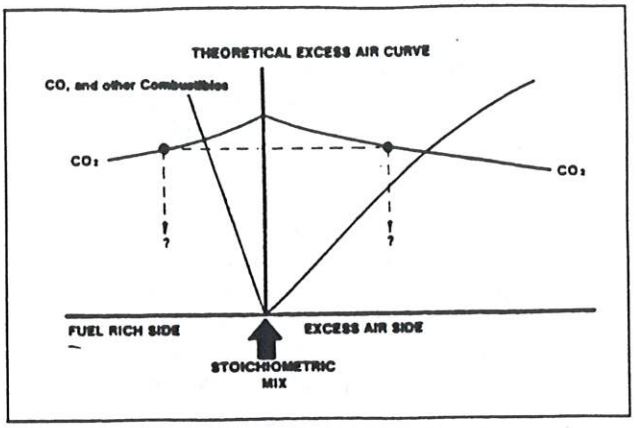


FIG. 13.5.2. *Carbon dioxide levels alone do not determine proper fuel air mixtures.*

FIG. 13.5.2. shows the relationship of carbon dioxide and carbon monoxide production to the fuel/air mixture. Note that the same carbon dioxide reading can be achieved on either side of the theoretically ideal combustion known as stoichiometric combustion.

An overfired condition may yield proper carbon dioxide levels. However, carbon monoxide (CO) levels above .04% (400 parts per million) will be present if overfired or if combustion air intake is partially blocked. Carbon monoxide is a colorless, odorless gas which can be fatal if breathed in even small quantities.

Sample flue gas for carbon monoxide same way as carbon dioxide using the proper test instrument for CO.

Seal the hole in the vent pipe used for sampling with high temperature RTV silicone sealant after completing the test.

13.5.2. CHECKING CARBON MONOXIDE LEVELS IN FLUE GAS

Checking for carbon monoxide is also useful in setting proper combustion. carbon dioxide readings of 8.5-9% for natural gas and 9.7-10.7% for LP gas will be associated with acceptable carbon monoxide levels of 40-80 parts per million (.004-.008%) when on the excess air side and with unacceptable levels of about 400 parts per million (.04%) or over when on the fuel rich side.

13.5.3. CHECKING AIR TEMPERATURE RISE THROUGH THE FURNACE

Temperature rise through the furnace will vary according to input or air flow rates. At a given input, proper air flow rates will produce a temperature rise

(difference in temperature between supply and return air) of 40 to 70°F. If temperature rise exceeds 70°F, noisy operation of the unit may occur because water in the heat exchanger flashes to steam. This condition may occur even though outlet water temperatures are below 212°F.

To insure that a proper duct system has been installed and the system is working properly, take simultaneous readings of both the supply and return air plenum temperatures with the furnace fired. See FIG. 13.5.3. The difference between these two readings is the temperature rise through the furnace and should be 40 to 70°F. If a temperature difference of greater than 70°F is found, a higher blower speed setting or less restrictive duct system may be needed. Reducing the input will also decrease temperature rise.

Drill holes and insert appropriate temperature probes in the cold air return and warm air supply plenums and take simultaneous readings of air temperatures with the furnace running. Temperature rise is the difference of these two readings. The UF series furnace is designed for a temperature rise across the coil in the range of 40-70°F. Therefore if return air temperature is 70°F, supply air should be in the range of 110-140°F.

If temperature rise is greater than 70°F, low air flow should be suspected. If temperature rise is less than 40°F, high air flow may be suspected, though this situation is less common and less bothersome.

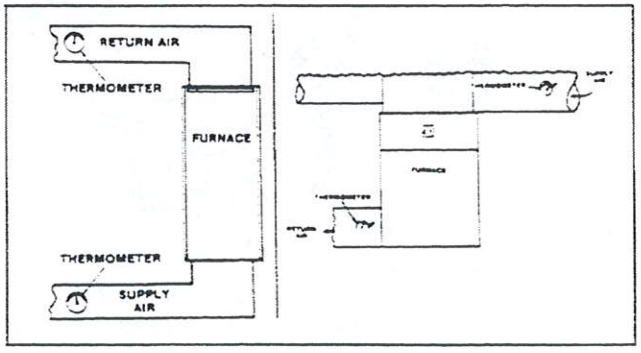


FIG. 13.5.3. *Measuring air temperature rise through the UF series furnace.*

13.5.4. MEASURING WATER TEMPERATURE RISE THROUGH HEAT EXCHANGER

Simultaneous readings taken on both the return water to the boiler shell and supply water to the warm air coil will give temperature differential values which indicate certain conditions in the operation of the system. A temperature differential of 20°F. is proper.

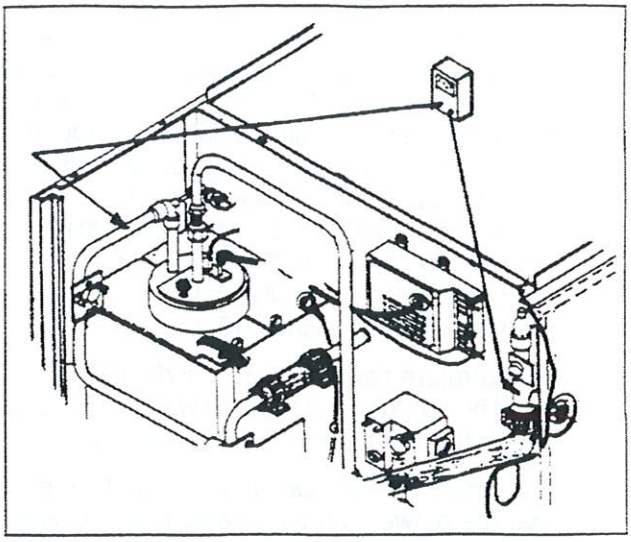


FIG. 13.5.4. *Measuring water temperature rise through the furnace's heat exchanger will provide information regarding pumping rates.*

Attach two surface probes to the water piping in the furnace's control compartment and take simultaneous readings of the two pipes with the furnace firing and the air circulating blower running. Allow a minute or two for the furnace to reach stable operation and observe the difference between the two temperatures. If temperature rise is less than 20°F no adjustment is necessary.

13.5.5. MEASURING WATER TEMPERATURE DROP THROUGH WT WATER HEATER

Temperatures differentials between boiler water entering and leaving the WT series water heater's heat exchange coil should be about 20°F to provide stable operation. A temperature differential of greater than 22°F indicates that boiler water flow through the heat exchanger is inadequate and will lead to inefficient operation and possible noise caused by boiler water within the boiler heat exchanger flashing to steam.

Proper boiler water flow rates are essential to effect good heat transfer. Inadequate flow rates may be corrected by adding a booster pump or increasing the pipe size to provide less restriction to flow. Measure temperature drop through the WT series tank heat exchanger as described in SEC. 13.5.4 with the water heater running and the probes mounted on the tank's boiler water supply and return piping.

13.5.6. MEASURING WATER TEMPERATURE DROP THROUGH WARM AIR COIL

Temperature differentials between boiler heat exchange fluid entering and leaving the warm air coil should be about 20°F and the furnace will reach a stable temperature differential when operating properly. If the coil becomes clogged with dirt or air flow across the coil is insufficient, water temperature drop across the coil will be less than the rise in temperature through the boiler coil. The furnace will then cycle on its operating limit. For information regarding cleaning the warm air coil see SEC. 15.2.4.

Temperature rise above 20°F indicates that the heat is not being extracted from the water and more air flow across the warm air coil may be needed.

A temperature rise less than about 14°F may mean that the blower can be slowed down. Check supply plenum air temperatures and if below 110°F, move the fan speed tap to the next lower speed to give optimum comfort levels.

Enough air must be moved through the warm air coil by the circulating blower to extract heat from the heat exchange fluid at the same rate as the primary heat exchanger is adding heat to the fluid. The boiler coil and warm air coil have been designed to attain a stable operating condition when installed on a well-designed duct system.

Protect the coil from clogging with dirt, hair, and lint by installing and maintaining the proper type of return air filter. A washable fiber filter is provided with the furnace or the installer may elect to furnish a filter rack and disposable filters to accomplish this task. Inform the homeowner of the need to keep the filter clean for]the sake of efficiency and a cleaner heated environment.

13.6. BALANCING AIR FLOWS

Systems should be balanced to assure adequate heat delivery to each room. Installation of dampers in each heat run will facilitate system balancing. If designed properly the system should produce even temperatures in all of the rooms. A damper in each heat run will allow restriction of air flows to some rooms in favor of others to permit system balancing.

13.7. SETTING THERMOSTAT HEATING ANTICIPATOR

Thermostats usually contain heat anticipators to deal with the operating differential of the system to be controlled. The heat anticipator is a resistance heater located near the bimetal element in the thermostat which heats when the thermostat contacts close. The heat from the anticipator coil raises the temperature of the bimetal element faster than the surrounding air, causing the thermostat to shut off the heating system faster than would air temperature alone.

This anticipation prevents objectionable heating overrun and keeps room temperatures closer to the set point. Low voltage thermostats have adjustable anticipators to match the exact current draw of the heating system. The thermostat's heat anticipator should be set at 1.0 amp for proper operation.

The optimum setting can best be achieved by measuring the actual draw of the circuit as shown and setting the anticipator accordingly. Control wiring lengths and variables within the relay coil will cause some differences to the approximate rating of 1.0 amp.

Many electronic thermostats use a different type of anticipator to perform the same function. Check the thermostat manufacturer's recommendation for setting the anticipator on electronic thermostats. Programmable electronic thermostats may also require the use of isolation relays. Check the thermostat manufacturer's recommendations.

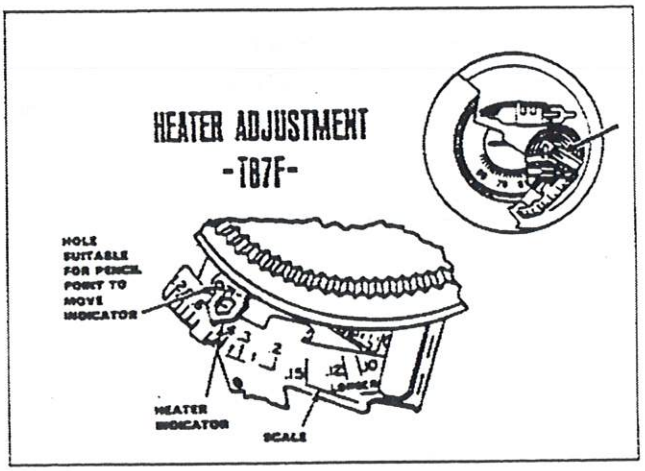


FIG. 13.7. *Set the thermostat heat anticipator to 1.0 amps for UF series furnace or read actual amp draw as described in SEC. 13.7.1.*

13.7.1. ANTICIPATOR SETTING

Anticipator settings depend on the circuit to which the thermostat is connected. The furnace relay will give a 1.0 amp draw if the thermostat is connected directly to the furnace's R and W terminals. If the thermostat controls an isolation relay, take an amp draw reading and set the anticipator accordingly. Turn off power to

the system and remove the thermostat from the subbase or wall plate. Wrap exactly 10 turns of wire around the jaws of a split jaw induction type current meter. See FIG. 13.7.1. Connect one end of the wire to R and the other to W. Restore power to the furnace and allow the system to run for approximately one minute. Read the amp scale and divide the reading by 10 to obtain the current draw. A meter reading of 2 amps in this configuration will correspond to an amp draw of .2 amp.

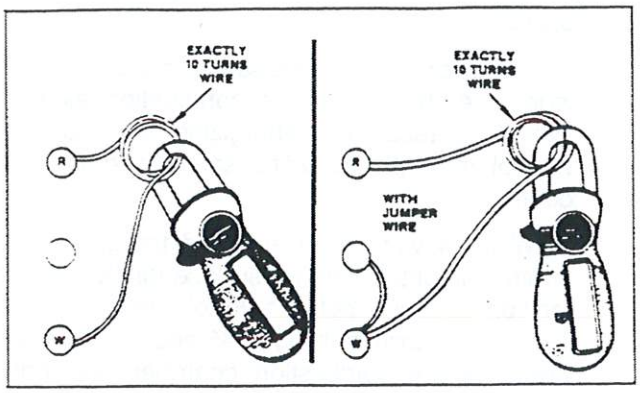


FIG. 13.7.1. *Reading thermostat circuit amp draw to set thermostat anticipator.*

13.7.2. HEATING AND COOLING THERMOSTATS

A dual function thermostat is required to control a system which includes air conditioning. Air conditioning is typically run with the highest available blower speed while heating in the UF furnace is accomplished on medium-high speed for the 80,000 BTU furnace and medium-low for the 60,000 BTU furnace. A double pole, single throw relay is mounted on a junction box on the furnace's air circulating blower which switches to the high speed setting automatically on a call for cooling. On most heat/cool thermostats the manual-on fan setting also can run the fan if constant air circulation is desired.

A separate cooling contactor relay installed in the outdoor condenser unit will initiate condenser operation in cooling mode. The cooling contactor and the R2 fan relay are both energized by the thermostat on a call for cooling. A separate wire from the thermostat's manual-on fan switch will power the fan relay only without powering the compressor contactor.

14. SEQUENCE OF OPERATION

UF series Furnaces prior to serial number 895300000 include direct-spark ignition systems to light the main burner. Furnaces produced after serial number 895300000 include hot surface ignition (HSI) systems. Both systems light the burner directly and have no pilot flame. All safety devices in the furnace operate on low voltage (24 vac). Direct spark units may be converted to hot surface ignition if desired.

14.1. DIRECT SPARK IGNITION

NORMAL START

1. Thermostat calls for heat making the circuit between R and W terminals on the circuit board located on top of the 24v transformer.

2. Combustion air blower relay R_1 is energized closing line voltage contacts in R_1 starting the combustion air blower.

3. Proper pressure or pressure differential is established thereby closing the combustion air pressure switch contacts and energizing the flame safety control through the unit's safety and temperature controls.

4. With the flame safety control energized the ignitor begins sparking and the main gas valve opens and the burner ignites.

5. If flame is proven through the flame sensor rod the main gas valve will remain open and burner will continue to run.

6. Water in the boiler is heated and delivered to the heat distribution system.

NORMAL SHUTDOWN

1. When the thermostat is satisfied, the thermostat contacts open and the circuit from R to W is broken.

2. The main gas valve is de-energized and closes interrupting the flow of gas and extinguishing the burner.

3. The combustion air blower relay R_1 is de-energized interrupting power to the combustion air blower and the circulating pump.

14.2. HOT SURFACE IGNITION

NORMAL START

1. Thermostat calls for heat making the circuit between R and W terminals on the circuit board located on top of the 24v transformer. If a relight timer is used a one minute delay between the call for heat from the thermostat and the beginning of the ignition sequence will occur.

2. Combustion air blower relay R_1 is energized closing line voltage contacts in R_1 starting the combustion air blower.

3. Proper pressure or pressure differential is established thereby closing the combustion air pressure switch contacts and energizing the flame safety control through the unit's safety and temperature controls.

4. With 24 volt power supplied through the safety control circuits to the hot surface ignition control the ignition control supplies 115 volts to the hot surface igniter. Approximately 35 to 45 seconds is allowed to prepurge the combustion chamber and bring the igniter up to temperature.

5. 24 volts is supplied to the gas valve and the gas valve opens after preheat.

6. Hot surface igniter is de-energized and switches to flame sensing mode.

7. Gas valve remains open and burner remains on until thermostat is satisfied. Sequence is identical for water heating mode.

ABNORMAL SEQUENCE

1. If the hot surface igniter fails to light the burner within ten seconds the gas valve will close and the ignition cycle will begin again.

2. If the burner fails to ignite on the third try the control will lock out and remain locked out until power is interrupted for thirty seconds to reset the control.

NORMAL SHUTDOWN

1. When the thermostat is satisfied the 24 volt circuit will be broken, the R_1 relay will be de-energized stopping the combustion air blower, and the gas valve will close.

2. If a relight timer is used the 24 volt circuit will be interrupted after thirty minutes of continuous run time and the ignition control will be reset. If the unit has been in lockout, another series of tries for ignition will be started.

The UF series furnace includes a direct-spark ignition system to light the main burner. The furnace has no pilot flame to light and all safety devices in the furnace operate on low voltage (24 vac).

14.3. FURNACE CONTROLS AND SAFETY DEVICES

UF series furnaces include low voltage safety controls to prevent firing in the event of intake or flue blockage, temperature activated controls to prevent overheating of heat transfer solution and flue gas, and a pressure control to insure that the heat exchanger is filled with water and the water circulator pump is operating properly to prevent dry-firing.

The furnace also includes a line voltage, temperature sensing switch to control the circulating air blower and the water circulating pump.

14.3.1. TEMPERATURE LIMIT CONTROL

The temperature limit control is an adjustable, temperature actuated single-pole, single-throw, normally closed switch which governs the normal water supply temperature and subsequent air temperature to the heat distribution system. The temperature limit control is mounted on a metal plate brazed to the boiler outlet pipe next to the auxiliary limit control. The accompanying chart indicates the part number and ratings of the control on each model of UF furnace.

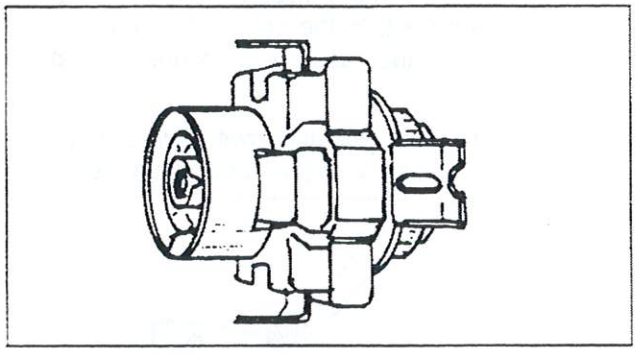


FIG. 14.3.1. *Temperature limit control.*

The operating control has a fixed differential of 15°F. If the control opens on high temperature, boiler water temperature will have to fall 15°F before the circuit is reclosed and the unit refires. During the time the control is open, the R_1 relay will remain energized and the combustion air blower and circulating pump will continue to run because of the brown wire running from the temperature limit control to the "G" terminal on the transformer terminal board which will keep the relay coil energized and the contacts made. Normal operation of this control with a WT series hot water heater will require setting the limit to its highest "E" setting.

14.3.2. AUXILIARY LIMIT CONTROL

The auxiliary limit control is mounted on the same plate on the boiler outlet piping as the temperature limit control and acts as a backup to shut the burner down should the temperature limit fail in the closed position. Like the temperature limit control, the auxiliary limit is temperature activated.

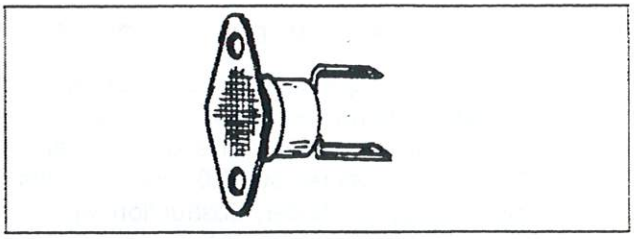


FIG. 14.3.2. *Auxiliary limit control*

Temperature differential for the auxiliary limit control is fixed at 15°F. which means that boiler water will have to cool at least that amount before the unit will refire. The combustion air blower and the circulating pump will continue to run with the auxiliary limit open on high temperature but the gas valve will be de-energized and will extinguish the burner. See the accompanying chart for part numbers and temperature ratings of the auxiliary limit for the furnace.

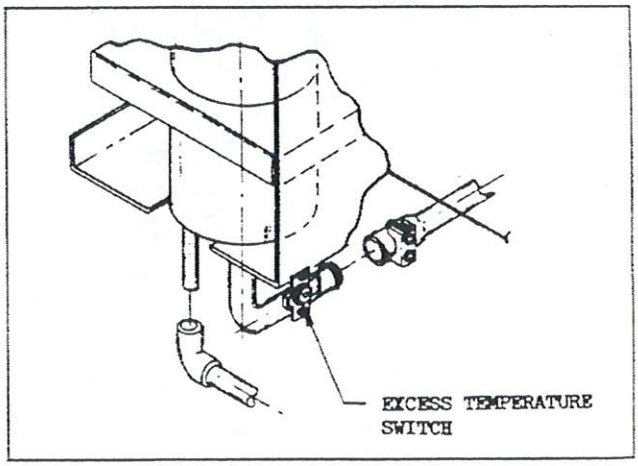


FIG. 14.3.3. *Excess flue gas temperature switch.*

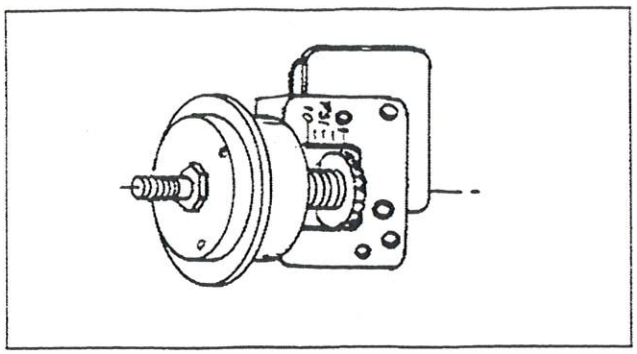


FIG. 14.3.4. *Water pressure switch.*

14.3.3. EXCESS TEMPERATURE SWITCH

The excess temperature switch is designed to sense flue gas temperature and to open at 200°F. Flue gas temperatures in the UF series furnaces rarely exceed 160°F. Temperatures over 200ł indicate loss of water flow through the boiler, obstruction within the heat exchanger limiting the flow of heat through the exchanger to the heat transfer fluid, or an overfired condition.

The excess temperature limit on UF series furnaces must be reset manually after the problem which caused the switch to open is remedied and temperatures within the flue piping drop by about 40°F.

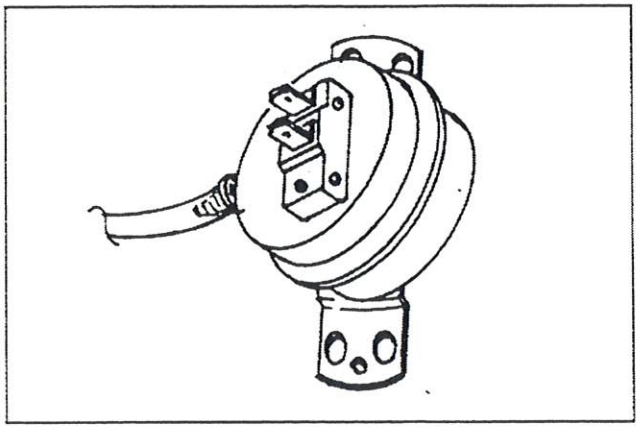


FIG. 14.3.5. *Combustion air pressure switch.*

14.3.4. WATER PRESSURE SWITCH

The water pressure switch is a diaphragm-actuated switch which proves that the furnace has been filled with water to avoid dry-firing and the pump is developing the appropriate amount of head pressure (greater than 2 psi). If the switch does not close, 24 vac power will not be delivered to the flame safety control in the ignition module and the burner can not start. The gas valve will not receive power to open. The water pressure switch is connected to a tee in the boiler water outlet piping just above the boiler shell.

14.3.5. COMBUSTION AIR PRESSURE SWITCH

The combustion air pressure switch is a safety device which will prevent the boiler from firing in the event of intake or flue pipe blockage. The pressure switch mounted on the right side of the furnace's cabinet senses pressures on either side of the intake air orifice through the two tubes connected to the intake piping. The switch contains a diaphragm which responds to air pressure differential within the proper range of across the intake orifice.

Air moving through an orifice experiences a pressure drop from one side of the orifice to the other. Suction (negative) pressures are greater on the side toward the combustion air blower's intake than ahead of the orifice. Any obstruction in either the intake or flue will decrease air flow and decrease the pressure differential. The combustion air pressure switch senses the difference in pressure and will open if and when the differential falls below the established limits and shut off the flow of gas to the burner.

14.3.6. FLUE GAS PRESSURE SWITCH

A second diaphragm-type air pressure switch is connected to a tapping in the burner mounting plate by 1/4" aluminum tubing. This flue gas pressure switch is normally closed and reacts to an increase in pressure within the combustion chamber above 6" w.c. An increase in pressure indicates exhaust blockage.

The flue gas pressure switch will safely shut the unit down and prevent pressure within the exhaust piping

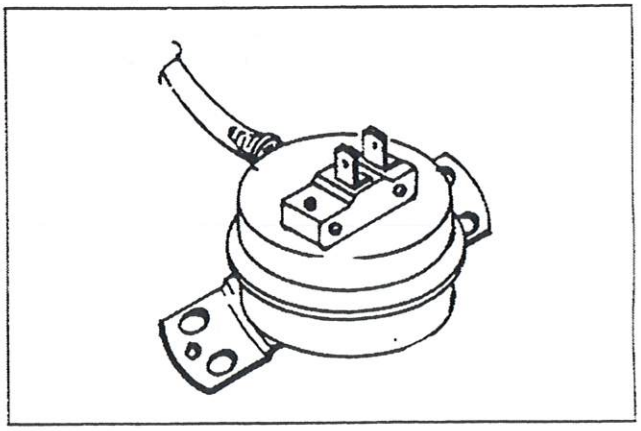


FIG. 14.3.6 *Flue gas pressure switch.*

from blowing the water out of the condensate trap and allowing byproducts of combustion from contaminating indoor air. The flue gas pressure switch is in series with the other safety controls in the low voltage safety circuit wiring and will interrupt power to the gas valve.

14.3.7. BLOWER SWITCH

The blower (air circulating blower) is controlled by a thermally activated switch which will start the blower when water temperatures within the return water pipe from the warm air coil reach about 125°F. The blower switch is located on a plate brazed to the return water piping just after the warm air coil within the furnace's control cabinet. This switch controls a line voltage circuit and 115 vac current is present at the contacts at all times.

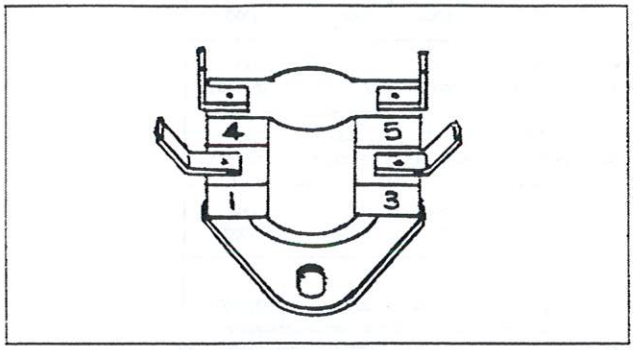


FIG. 14.3.7. *Blower switch.*

14.4. DESCRIPTION OF PARTS

By understanding the operation of the individual controls and parts and the way they react and interact, service and troubleshooting are made easier. The following sections list the various operating components and their functions.

14.4.1. ORIFICES

Three metering orifices govern the combustion process and provide the proper gas/air mixture to the burner: the gas orifice, the combustion air orifice, and the discharge orifice.

14.4.2. GAS ORIFICE

The dish-shaped aluminum gas orifice is located in the iron pipe union just below and downstream from the gas valve. The difference in pressure on either side of the orifice causes the metered flow of gas through the orifice. The precise size of that orifice dictates the firing rate of the burner at a given pressure. Changes within a range dictated by the orifice can be affected by adjusting the pressure of the gas upstream of the orifice with the gas valve's pressure regulator. Because of the difference in BTU value of natural and LP gases, different orifices are required for each gas to provide the specified input. See TABLE 15. for a listing of all orifices used in the UF series furnaces.

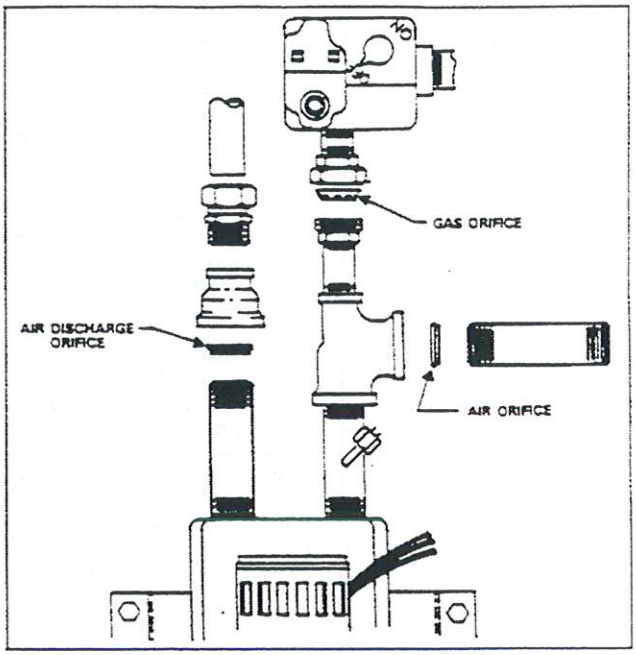


FIG. 14.4.2. *Exploded view of the gas, air, and discharge orifices and their locations.*

14.4.3. COMBUSTION AIR ORIFICE

For proper and complete combustion at the metered gas flow rate, combustion air must be metered in proportion to the flow of gas. The pressure differential developed by the combustion air blower causes air to flow through the combustion air orifice at a known rate based on air density, differential pressure, and the size of the orifice. See TABLE 15.

The combustion air orifice is press fit in the special 1-1/4" black iron pipe nipple upstream of the reducing tee on the suction side of the combustion air blower. The orifice is in the end of the nipple which is threaded into the reducing tee. This nipple is also tapped upstream of the combustion air orifice to accept the adaptor fitting for the combustion air pressure switch's low pressure side and the vent tubing for the gas valve pressure regulator.

By tying the gas valve's atmospheric vent into the intake piping, any restriction to air flow will cause an

MODEL NO. UF060D14R	GAS ORIFICE SIZE/PART NUMBER		AIR PRESS. SWITCH SETTTING/PART NO.		SUCTION AIR ORIFICE SIZE'PART NO.		DISCHARGE AIR ORIFICE SIZE/PART NO.	
ALT	NAT	LP	NAT	LP	NAT	LP	NAT	LP
SEA LEVEL	#28 2500025	#41 2500055	4.0"W.C. 2100015	4.0"W.C. 2100015	.562 2500004	.562 2500004	.437 2500001	.437 2500001
3000'	#28 25000025	#43 2500026	2.0"W.C. 2100006	2.0"W.C. 2100006	.562 2500004	.562 2500004	.437 2500001	.437 2500001
4000'	#28 2500025	#43 2500026	2.0"W.C. 2100006	2.0"W.C. 2100006	.562 2500004	.562 2500004	.437 2500001	.437 2500001
5000'	#28 2500025	#45 2500040	2.0"W.C. 2100006	2.0"W.C. 2100006	.562 2500004	.562 2500004	.437 2500001	.437 2500001
6000'	#28 2500025	#45 2500040	2.0"W.C. 2100006	2.0"W.C. 2100006	.562 2500004	.562 2500004	.437 2500001	.437 2500001
7000'	#28 2500025	#45 2500040	2.0"W.C. 2100006	2.0"W.C. 2100006	.562 2500004	.562 2500004	.437 2500001	.437 2500001
8000'	#28 2500025	#47 2500039	2.0"W.C. 2100006	2.0"W.C. 2100006	.562 2500004	.562 2500004	.437 2500001	.437 2500001
9000'	#28 2500025	#47 2500039	2.0"W.C. 2100006	2.0"W.C. 2100006	.562 2500004	.562 2500004	.437 2500001	.437 2500001
10,000'	#29 2500048	#47 2500039	2.0"W.C. 2100006	2.0"W.C. 2100006	.562 2500004	.562 2500004	.437 2500001	.437 2500001
11,000'	#29 2500048	#47 2500039	2.0"W.C. 2100006	2.0"W.C. 2100006	.562 2500004	.562 2500004	.437 2500001	.437 2500001
MODEL NO. UF080D14R								
SEA LEVEL	#13 2500049	#31 2500054	.70"W.C. 2100013	.85"W.C. 2100013	.875 2500002	.875 2500002	.625 2500005	.562 2500005
3000'	#13 2500049	#33 2500036	.70"W.C. 2100013	.85"W.C. 2100013	.875 2500002	.875 2500002	.625 2500005	.562 2500005
4000'	#13 2500049	#33 2500036	.70"W.C. 2100013	.85"W.C. 2100013	.875 2500002	.875 2500002	.625 2500005	.562 2500005
5000'	#13 2500049	#34 2500037	.70"W.C. 2100013	.85"W.C. 2100013	.875 2500002	.875 2500002	.625 2500005	.562 2500005
6000'	#13 2500049	#36 2500050	.70"W.C. 2100013	.85"W.C. 2100013	.875 2500002	.875 2500002	.625 2500005	.562 2500005
7000'	#13 2500049	#36 2500050	.70"W.C. 2100013	.85"W.C. 2100013	.875 2500002	.875 2500002	.625 2500005	.562 2500005
8000'	#13 2500049	#38 2500027	.70"W.C. 2100013	.85"W.C. 2100013	.875 2500002	.875 2500002	.625 2500005	.562 2500005
9000'	#13 2500049	#38 2500027	.70"W.C. 2100013	.85"W.C. 2100013	.875 2500002	.875 2500002	.625 2500005	.562 2500005
10,000'	#14 2500032	#39 2500029	.70"W.C. 2100013	.85"W.C. 2100013	.875 2500002	.875 2500002	.625 2500005	.562 2500005
11,000'	#14 2500032	#39 2500029	.70"W.C. 2100013	.85"W.C. 2100013	.875 2500002	.875 2500002	.625 2500005	.562 2500005

TABLE 15. *Orifice and combustion air pressure switch combinations for various altitude and fuel configurations of the UF furnace.*

automatic reduction of the unit's firing rate and help keep gas/air mixtures proper over a wider operating range as an aid in preventing incomplete combustion and the production of noxious carbon monoxide.

14.4.4. DISCHARGE ORIFICE

The discharge orifice is press fit in the special 1›" black iron nipple downstream of the combustion air blower. This orifice presents the last metering step in supplying the correct amount of premixed gas and air to the burner. The discharge orifice is designed to deliver the proper flow of gas and air to the burner based on the pressure developed by the combustion air blower.

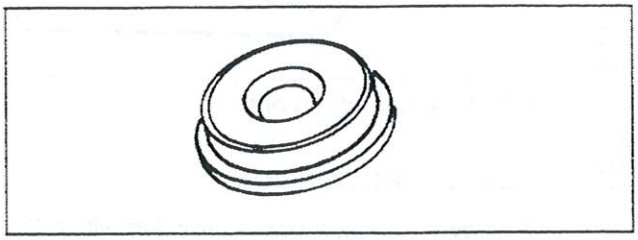


FIG. 14.4.4. *Discharge and combustion air orifices.*

14.4.5. BURNER ASSEMBLY

The burner is a rigid stainless steel pipe wrapped with a woven Inconel mesh fabric which acts as the flame surface, each opening in the mesh functioning as a burner port to give a steady, even flame for optimum heat transfer. The burner extends down into the combustion chamber and is surrounded by water flowing through the heat exchanger's finned tubing.

The burner is mounted to the heat exchanger's shell with six stainless steel screws and a fiber gasket to provide a positive seal preventing the escape of gases. When installing the burner, the screws should be coated with a high temperature RTV silicone sealant to prevent leaking gases and to ease screw removal at a later date.

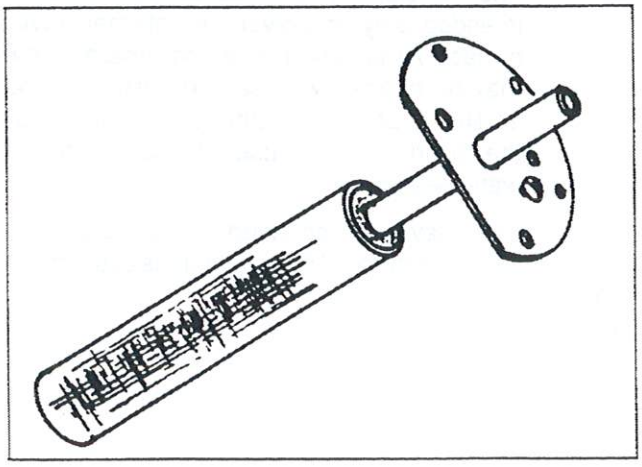


FIG. 14.4.5. *Burner assembly.*

The burner assembly also provides the mounting plate for the igniter/sensor assembly and a sight glass through which the flame can be observed.

14.4.6. HOT SURFACE IGNITER/SENSOR

Furnaces produced since serial number 895300000 are equipped with hot surface ignition systems. The igniter is made of silicon carbide material which when supplied with 115 volts heats to about 2000°F. and gives consistent lighting. The igniter also senses proper ignition through flame rectification. These igniters are quite fragile and must be handled carefully to avoid breaking but when installed require much less attention and maintenance than direct spark igniters since there is no gap to be set.

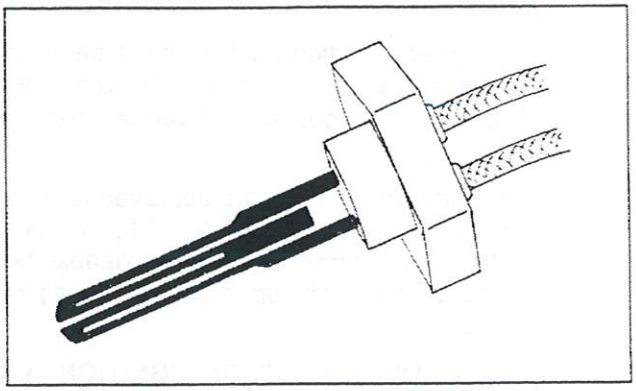


FIG. 14.4.6. *Hot surface igniter/sensor does both ignition and flame rectification duties.*

14.4.7. IGNITER/SENSOR ASSEMBLY

The igniter/sensor assembly consists of three rods, two with ceramic insulators and one bare, which provide the ignition spark, flame sensing, and grounding of the spark, mounted to a single plate which is in turn mounted on assembly, apply a coating of high temperature RTV sealant to the threads to prevent any gas leakage and to ease the subsequent removal of the screws.

Check the igniter/sensor assembly periodically for wear and deterioration, adjust or replace as necessary. Set the gaps as described in SEC. 15.1.3.

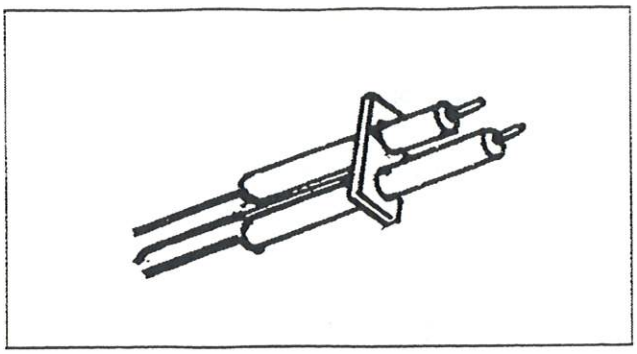


FIG. 14.4.7. *Spark igniter/sensor assembly.*

14.4.8. HOT SURFACE IGNITION CONTROL MODULE

Furnaces produced since serial number 895300000 are equipped with hot surface ignition systems. The ignition control module differs in that instead of producing 20,000 volts across a gap as in direct spark, the control produces a 115 volt current to the igniter. Flame rectification proves flame in essentially the same way as the direct spark ignition controller.

Hot surface ignition controls must be supplied with both a line voltage circuit and a 24 volt control circuit. The controller produces a 24 volt signal to operate the gas valve.

Two different controls are approved for use with the UF furnace: Fenwall's 05-32 HSI, and Honeywell's S89G. The controls are interchangeable, both give a prepurge and heat up cycle and multiple tries for ignition.

14.4.9. DIRECT SPARK IGNITION CONTROL MODULE

The ignition control module provides the circuitry necessary to generate a high voltage spark between the igniter and ground rods, to sense combustion through the flame's ability to rectify AC current to DC, and to shut off the flow of gas should the flame fail for any reason.

Two models of spark ignition control are used on the UF furnace: either Honeywell's S87D which gives a single 11 second try for ignition before lockout, or White-Roger's 50D20 which provides three 7 second tries for ignition before lockout. Except for the difference in the high voltage leads, the two are interchangeable.

If either module goes into a lockout condition power must be interrupted to the unit for about 30 seconds to allow the unit to reset. 24 vac power is provided to the ignition control through all the safety circuits of the boiler and the ignition control in turn controls power to the gas valve.

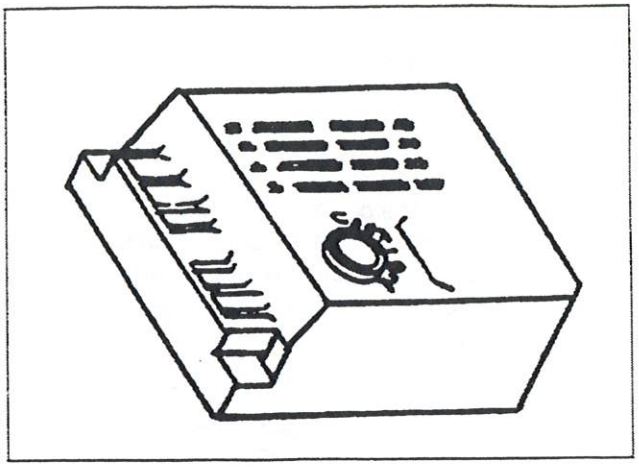


FIG. 14.4.9. *Ignition control modules.*

14.4.10. JUNCTION BOX

A 4" by 4" junction box is provided within the furnace for line voltage wiring. Furnaces produced since serial number 910100000 include a terminal strip within the box to ease line voltage wiring connection. Units produced prior to 910100000 use wire nuts for the same purpose.

14.4.11. CONTROL TRANSFORMER ASSEMBLY

The control transformer assembly, mounted on the 4 x 4 electrical box plate, contains the 24 volt power for safety, ignition, and control functions, and the receptacle for the combustion air blower/circulator pump relay, R_1.

The transformer is rated 25 vac at 40 va and is intended only to power the internal devices of the furnace. An isolation relay and separate power source may be needed with certain digital thermostats and additional power transformers are needed to control the diverter valves used to control the WT series water heater.

The relay base provided accepts a standard plug-in relay to control 115 volt functions of the furnace.

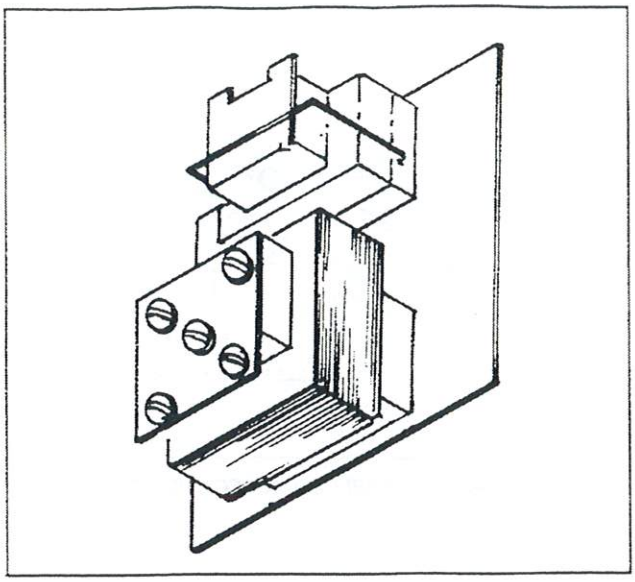


FIG. 14.4.11. *Control transformer assembly.*

14.4.12. R1 BLOWER/CIRCULATOR RELAY

The relay mounts on the base provided on the control transformer assembly and provides switching of the combustion air blower/water circulator. The double-pole, double-throw relay makes on a call from the room thermostat or the water heater through the R and W contacts.

Power is provided to the relay's coil through the excess temperature limit switch and the water pressure switch. Other controls in the circuit will not interrupt power to the relay's coil.

The other set of line voltage contacts conducts power to the circulating air blower by way of the blower cutout relay and the thermally activated blower switch. Unless power is provided to the relay's coil as on a call from the room thermostat, the circulating air blower can not run. This feature prevents unwanted blower run in water heating mode.

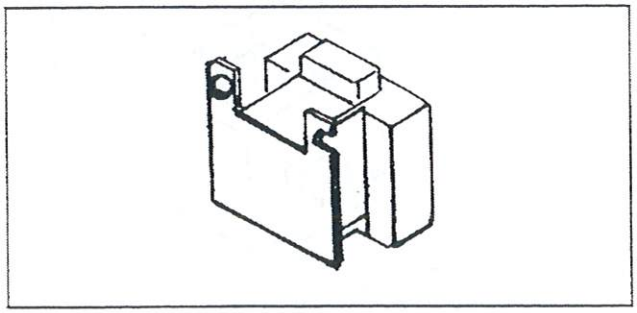


FIG. 14.4.12. *R_1 blower and circulator relay.*

14.4.13. COMBUSTION AIR BLOWER

The combustion air blower is a cast aluminum, dynamically balanced centrifugal blower which draws in combustion air, mixes the air and gas, supplies the gas/air mixture under positive pressure to the burner, drives the hot gases through the heat exchanger, and expels the by-products of combustion through the flue piping to the outside. The combustion air blower assembly includes a silencer to minimize the sounds created by the high air velocity within the blower.

Because of the close tolerances involved in this type of blower, the motor, blower, and silencer are replaced as a unit. No field repair is authorized.

The blower is driven by a 1/2 hp, 115 vac, 3450 rpm permanent split capacitor motor which contains permanently lubricated motor bearings. No maintenance is required on this component.

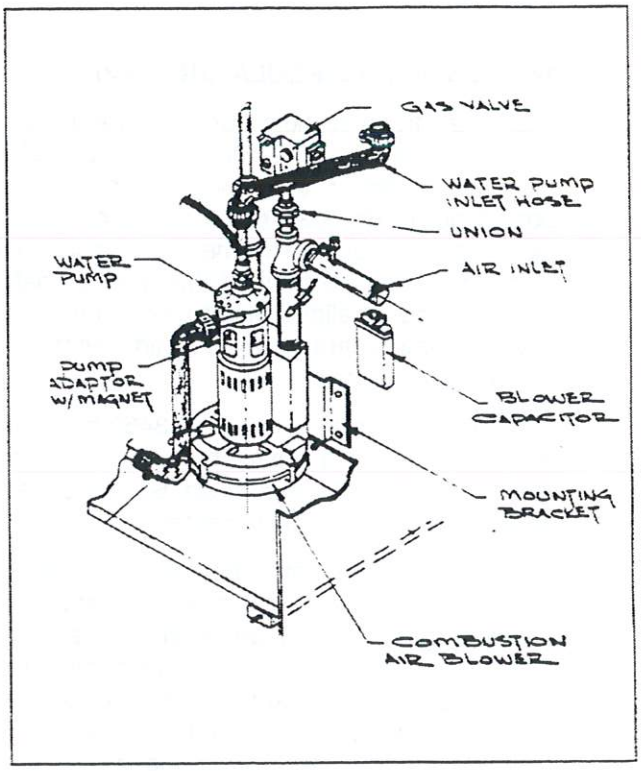


FIG. 14.4.13. *Combustion air blower and water circulator assembly.*

14.4.14. COMBUSTION AIR BLOWER MOTOR RUN CAPACITOR

A 12.5 micro farad capacitor mounted on the side of the boiler's heat exchanger bulkhead provides additional starting torque for the combustion air blower.

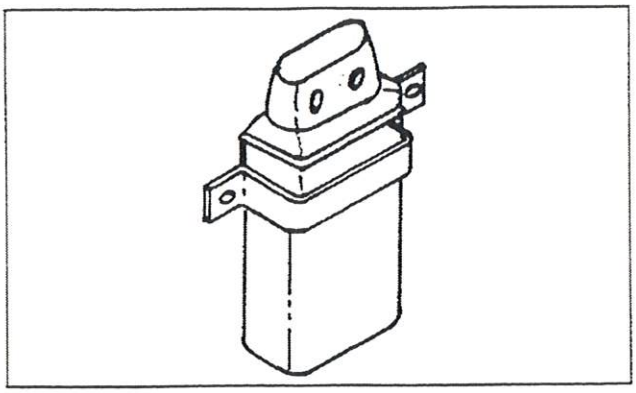


FIG. 14.4.14. *Combustion air blower motor run capacitor.*

14.4.15. WATER CIRCULATING PUMP

The heat transfer fluid, usually water, is forced through the boiler shell's coil and the warm air coil by the internal water circulating pump. The plastic-bodied pump mounts on top of the combustion air blower and is driven by the same double-shafted motor. Magnetic coupling of the motor's shaft to the pump's impeller eliminates the need for shaft seals and the pump's ceramic shaft minimizes the need for extensive maintenance.

At the motor's nominal speed of 3450 rpm, the pump develops sufficient head and flow to meet the requirement's of the UF furnace. See SEC. 11.5.2. for specific head characteristics of the pump.

If a WT series water heater is to be added, consideration must be given to the pump's capabilities. Piping the water heater's boiler loop in 1" rather than 3/4" copper pipe will minimize pumping requirements, but additional pumping may be required if the tank is set any distance from the furnace. 1" pipe is the minimum pipe size recommended.

A cup shaped magnet mounts directly to the motor shaft with a set screw and drives a stainless steel clad magnet bonded to the plastic impeller inside the pump housing.

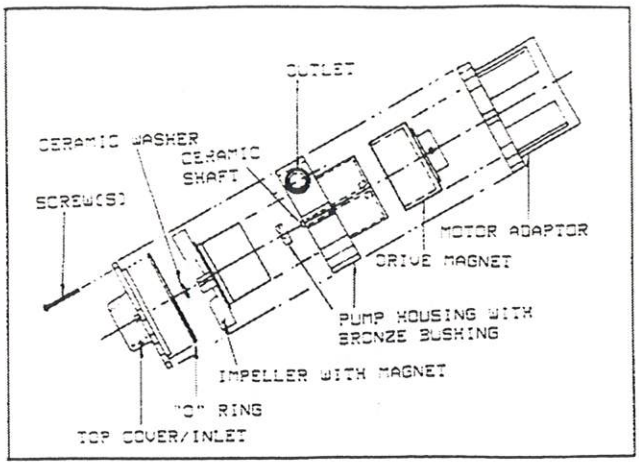


FIG. 14.4.15. *Heat transfer solution circulating pump.*

14.4.16. GAS VALVE

The gas valve is a standard combination type redundant valve with two 24 vac operating valves and is rated at pressures to 1/2 psig and a maximum capacity of 250,000 BTU/hr. It is located directly above and upstream from the combustion air blower inlet. The gas valve is controlled by the ignition control module.

The gas valve contains a pressure regulator which can be adjusted if necessary to achieve the proper input and combustion gas analysis for optimum operation. The pressure regulator's vent is tied into the negative pressure present in the combustion air intake piping upstream from the combustion air orifice by a piece of flexible aluminum tubing. This insures that any restriction of intake air will also restrict the amount of gas available to the burner in order to prevent a "too rich" fuel air mixture and resultant improper combustion.

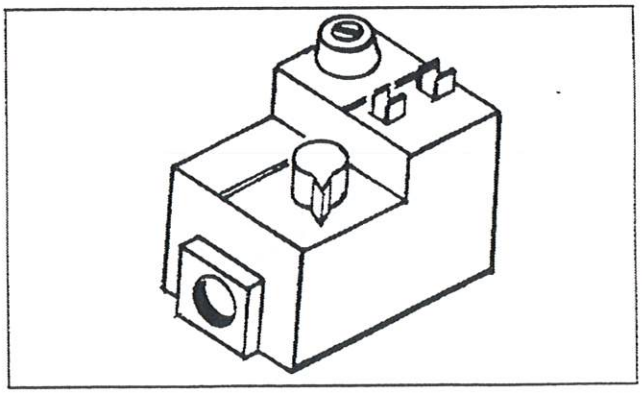


FIG. 14.4.16. *Gas Valve.*

14.4.17. HEAT EXCHANGER

The boiler shell is the primary heat exchanger which, through its combustion chamber and finned coil, transfers the heat produced in the hot gases of the combustion process into the circulating water. Head characteristics of the boiler coil are shown in SEC. 11.5.3.

The boiler tube has been designed to operate at a 20°F. rise through the heat exchanger (nominal flow of 1 GPM per 10,000 BTU of output).

For instance, an 80,000 furnace with rated output of 72,000 BTU will require a flow of about 7.5 GPM to yield the proper temperature rise. A temperature rise of less than 20 degrees, usually resulting from flows greater than 1 GPM per 10,000 BTU output, will only enhance the efficiency of the boiler. A temperature rise of more than twenty degrees will be detrimental to boiler operation and may lead to erratic operation and excessive cycling resulting in increased service problems and possible noise generated when water in the boiler flashes to steam.

The heat exchanger is made up of a cupronickel coil with stainless steel fins inside a welded stainless steel shell. Refractory material in the upper part of the combustion chamber protects the metal of the shell from excessive temperatures and a restrictor core in the center of the lower part of the heat exchanger coil forces the hot gases to flow through the fins for maximum heat transfer.

Water is pumped from bottom to top through the heat exchanger while hot gases are pumped from top to bottom. This counterflow arrangement optimizes heat transfer in all areas of the boiler.

14.4.18. RECUPERATIVE COIL

As the hot flue gases exit the primary heat exchanger they pass through a stainless steel serpentine coil mounted horizontally in the return air stream of the furnace. Return air is passed over the secondary heat exchanger and is preheated, thereby cooling the flue gases further, before passing over the warm air coil. Most condensation of the flue gases occurs in the recuperative coil. The furnace must be level for the condensate to flow to the condensate trap which is field installed on the flue outlet. See SEC. 12.1.4.

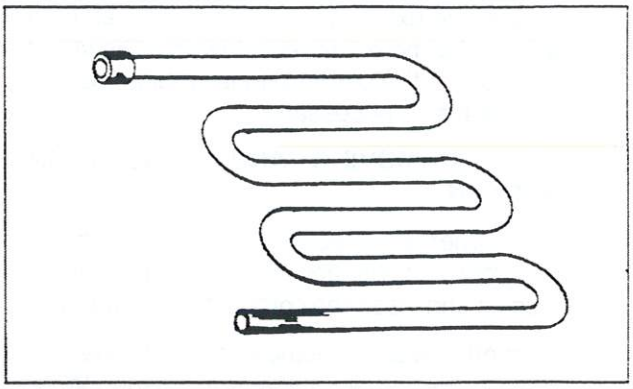


FIG. 14.4.18. *Recuperative coil.*

14.4.19. WARM AIR COIL

The aluminum finned copper water coil transfers heat from the boiler water passing through it to the air passing across and through the fins.

15. MAINTENANCE

The combustion air blower and air circulating blower contain permanently lubricated bearings which need no maintenance. Properly installed and set up, the unit burns cleanly and no cleaning of the vent system is required.

15.1. BURNER MAINTENANCE

The burner may require cleaning on a periodic basis. How often the burner will need to be cleaned will depend on the quality of the combustion air. Dusty conditions or air contaminated with solvents, paints, automotive exhaust fumes or the like at the air intake will require more frequent cleaning. GlowCore recommends that the burner be inspected at least annually and cleaned if necessary.

15.1.1. REMOVING AND REINSTALLING THE BURNER

The burner will need to be removed to inspect igniter assembly, to inspect and clean the burner, and to inspect and clean the combustion chamber.

Turn off gas and electric supplies to the furnace and remove the furnace cabinet top panel. With a 1-1/4" open end wrench loosen the compression fittings on each end of the gas/air tube at the burner and combustion air blower and remove the pipe. Disconnect the line voltage wire to the hot surface igniter on hot surface ignition models, or the high voltage lead to the ignitor rod and the flame sensor (blue) lead to the sensor rod on spark ignition models. With a 5/16" nut driver or common screw driver, remove the six 10/32 stainless steel hex head tapping screws which mount the burner to the top of the boiler shell.

When reinstalling the burner replace the burner gasket and coat the threads of the mounting screws with high-temperature RTV silicone sealant or an equivalent anti-seize material to ease subsequent removal of the burner.

15.1.2. CLEANING THE BURNER

Any of a number of methods may be used to clean the burner depending on what contaminant is present on the burner. With the burner removed, use compressed air to blow loose dust from the burner. Wash the burner with a detergent and water and flush with clear water or use an acid solution such as refrigeration coil cleaner, muriatic acid, or commercial drain cleaner in extreme cases.

The burner is made of stainless steel and will not be harmed by such chemicals. The burner may be soaked in the acid solution if necessary to remove residues caused by combustion air contaminated with chemicals or solvents. Flush the burner with tap water and observe the pattern of water flow through the burner mesh before reinstalling as described above. Water under pressure should flow evenly through the burner mesh with no one area showing more or less flow than the rest of the burner surface.

15.1.3. SETTING IGNITOR/SENSOR ELECTRODES

When cleaning and inspecting the burner on spark ignition models, check for proper ignitor/sensor/ground rod gaps. Some warping or erosion of the rods may be possible over time. Replace the ignitors if necessary with the proper replacement part and set the spark gaps as indicated in the accompanying chart. Replace the fiber gasket between the ignitor rod assembly and the burner mounting plate each time the ignitors are removed and reinstalled.

With the burner removed, bend the ignitor and sensor rods to the specifications shown in FIG. 15.1.3. This process can be made easier by using a feeler gauge made from wooden dowel rod or tubing with the appropriate outside diameter. Bend the ground rod toward the ignitor rod and set the proper gap.

RISK OF ELECTRICAL SHOCK IN THE FOLLOWING PROCEDURE. BE CERTAIN THAT GAS IS TURNED OFF AND BURNER IS CLAMPED SECURELY TO THE FURNACE CABINET AND PROPERLY GROUNDED. DO NOT TOUCH IGNITER OR BURNER WHILE ELECTRICITY IS TURNED ON.

Proper spark operation can be checked visually with the burner removed. Be sure main gas valve is off before proceeding with the following test. A high voltage spark is generated so do not touch electrical components during this test as there is a strong risk of electrical shock.

HIGH VOLTAGE ARC PRESENT. BE CERTAIN GAS IS TURNED OFF. DO NOT TOUCH IGNITOR OR BURNER WHILE ELECTRICITY IS TURNED ON.

WARNING

Clamp the burner to the furnace cabinet close enough to the ignitor control to allow the high voltage lead to be connected. Be sure the burner is grounded. With the gas turned off and R to W terminals made, cycle the unit and observe the spark produced.

An electrical arc will be observed between the ignitor rod and ground rod only. No arc should be observed between the ignitor and the face of the burner or to the sensor rod.

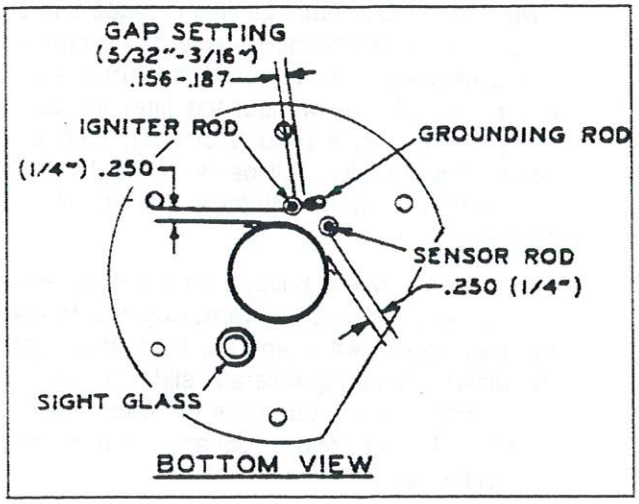


FIG. 15.1.3. *Igniter/sensor gap settings.*

15.1.4. REPLACING THE IGNITOR ASSEMBLY

With the burner removed as above, remove the two 6-32 (4-40 on earlier models) stainless steel hex head tapping screws which mount the assembly to the burner mounting plate. Replace the ignitor gasket and ignitor assembly with the appropriate part and set the gaps as described above. Coat the threads of the screws with high temperature RTV silicone sealant or an equivalent anti-seize material to ease subsequent ignitor removal.

15.2. HEAT EXCHANGER MAINTENANCE

Heat exchangers may need cleaning if combustion air is contaminated with chemicals, solvent fumes, or fine particulate matter which can pass through the burner and adhere to the heat exchanger. A buildup of material on the heat exchanger will result in high exhaust temperatures, restriction to the flow of gases, and will ultimately cause the combustion air differential switch to open and shut down the burner.

Some build up of a greenish crystal on the heat exchanger coil is normal and, unless extreme, will not adversely affect heat exchanger performance. These crystals are normally caused by condensate reacting with the cupronickel of the heat exchanger, particularly where contaminated with chlorine fumes as from municipal water systems or laundry bleach. If the heat exchanger must be cleaned, use a good grade of nickel-safe coil cleaner as used on air conditioning or ice-maker coils.

COIL CLEANERS CONTAIN ACIDS WHICH CAN CAUSE EYE AND SKIN IRRITATION. USE CAUTION AND PROPER SAFETY EQUIPMENT WHEN HANDLING COIL CLEANERS. DISPOSE OF USED COIL CLEANERS PROPERLY. REFER TO PRODUCT LABELING FOR PROPER PROCEDURES.

WARNING

Disassemble the union in the condensate trap and insert a plug in the pipe end to allow filling of the heat exchanger with coil cleaner solution or use a plastic condensate pump to continuously flush the heat exchanger surface until clean. Allow adequate time for the solution to work.

Most solutions will work quicker if heated. This can often be accomplished by running the circulator in water heating mode while cleaning. Hot water from the water heater will warm the cleaning solution and speed the process.

After draining the solution, reassemble the condensate trap union and flush thoroughly with water.

15.2.1. INSPECTING COMBUSTION CHAMBER

With the burner removed, inspect the fire side of the heat exchanger and the restrictor in the lower section of the heat exchanger for any debris or scaling. Check the area around the top of the restrictor for any foreign matter or any deterioration of the restrictor.

Pay particular attention to the top of the combustion chamber, the area just below the burner mounting surface. Wet pack refractory material must be in place and must be replaced if damaged to protect the shell of the boiler from excessive temperatures. Replace the burner gasket when reinstalling the burner.

Some reduction in fin size in the area immediately surrounding the burner is normal and may be seen as loose particles in the condensate drain or on top of the restrictor. This deterioration of the fins is due to the high temperatures in close proximity to the burner and will stabilize over time. It is of little or no consequence to the boiler's performance or durability. Vacuum the particles from the combustion chamber and/or flush with water.

Should the restrictor become loose or damaged, flue gases will exceed the maximums stated in SEC. 16.1.1.3. Take flue gas temperature readings by inserting a temperature probe into the exhaust stream through the hole drilled for CO_2 testing.

15.2.2. CLEANING COMBUSTION CHAMBER

The process of burning natural gas consumes combustion air in the ratio of about 12 to 13 cubic feet of air for each cubic foot of natural gas. An 80,000 BTUH UF furnace will use 960 to 1,040 cubic feet of air for each hour of run time. Therefore, any contaminants such as dust, automotive exhaust fumes, or airborne chemical vapors, no matter how minute the concentrations present in combustion air, will tend over time to build up in the burner or combustion chamber. To maintain effective heat transfer, these deposits must be removed if present.

If annual inspection reveals any buildup on the heat exchanger the following procedure is recommended: first, remove any loose debris with a vacuum cleaner. Use a wire brush, a 2-1/2" boiler brush as used on fire-tube boilers works well, to dislodge any material clinging to the heat exchanger and vacuum out the resulting debris. Avoid physically damaging any of the refractory material, either the boiler core restrictor or the refractory at the top of the combustion chamber. In most cases, the preceding will adequately clean the surfaces.

Flush any remaining fine debris through the boiler with tap water. The water will drain through the condensate trap. Clean out any debris which collects in the condensate trap. In extreme cases, the heat exchanger can be cleaned with an acid based coil cleaner as described above.

15.2.3. RESTRICTOR INSPECTION

With the burner removed, check the condition of the restrictor in the center of the lower part of the heat exchange coil. The restrictor will not normally show any signs of damage unless care is not exercised when brushing debris off the heat exchanger. No maintenance is required for the restrictor.

15.2.4. WARM AIR COIL CLEANING

If good filter maintenance practices are followed, always keeping a return air filter in place and cleaning or replacing when needed, no cleaning of the warm air coil is necessary. However, if the furnace is run for any period of time without the filter in place under dusty conditions, a buildup of dust, hair, etc., may occur. This buildup will be detected by a reduced temperature drop through the warm air coil (see SEC. 13.5.6.).

To remove any dirt buildup on the coil, remove the circulating air blower by removing the blower compartment door switch and the hold down screws on the blower mounting rails and slide the blower out of the cabinet. Reach up inside the cabinet with a long vacuum cleaner crevice tool and vacuum the underside of the coil.

An inspection port may be cut in the side of the warm air plenum to reach the topside of the coil and dirt may be blown off the coil with compressed air if desired. Remove the blower before applying compressed air and vacuum the debris produced from the bottom of the blower cabinet before reinstalling the blower. Cover the inspection port and seal for proper air circulation after the cleaning job is complete.

Advise homeowners to replace filters on a regular basis for a cleaner home environment and to prevent the need for cleaning the warm air coil.

16. TROUBLESHOOTING

Many of the problems seen in the field can be traced and corrected quickly and accurately if a methodical approach is coupled with a basic understanding of the technology and the equipment. In a system with so many individual components, each must do its job correctly for the entire system function. Problems of application may manifest themselves as component failures. By designing systems to be compatible with the furnace, especially in terms of furnace size selection, pumping, air flow across the warm air coil, and optimum loads, most common problems can be avoided.

The following text attempts to create a path to follow in troubleshooting the UF furnace and lists the tools and instruments necessary to effectively diagnose any problems encountered.

16.1. TOOLS AND INSTRUMENTATION

See the accompanying chart for a list of the suggested tools and instruments and their most common uses. The list includes items to be included in the serviceman's tool kit in addition to normal hand tools. All the tools suggested here will probably already be in most well equipped service trucks.

TOOL/INSTRUMENT	USE FOR
1-1/4" open end wrench	Removal and installation of burner gas/air tube.
5/16 nut driver	Removal and installation of burner from boiler shell.
3/16 nut driver	Removal and installation of ignitor and sensor assembly.
1/4" O.D. tube or dowel	Feeler gauge to set ignitor and sensor rod gaps.
Volt-ohm meter	Circuit testing, continuity testing.
Digital thermometer	Checking temperature rise through the boiler and temperature drop through system, check flue gas temperature. (Differential capability required to take two simultaneous readings)
U-tube manometer	Check gas pressures, troubleshoot burner, gas/air system, venting.
Combustion analyzer	Fine tune combustion for peak performance and dependability.

16.1.1. VITAL SIGNS

The following values have been established to assist the skilled service person in verifying the proper subcomponent function.

Proper tools as listed above and training are necessary to properly measure and interpret the values shown below. Unqualified persons should not attempt to service this equipment.

16.1.1.1. ELECTRICAL VALUES

Low voltage transformer output:	18 VAC at 110 VAC input 24 VAC at 120 VAC input
Relay coil current draw:	.25 amp
Relay contactor rating:	12 amp
Combustion air blower current draw:	3.0-3.5 amp
Hot surface ignitor current draw:	3.0-5.0 amp
Combustion air blower capacitor:	12.5 mfd 370 VAC

16.1.1.2. GAS PRESSURES

Natural gas supply:	5.0-10.5" w.c. ahead of valve with unit operating
LP gas supply:	11.0-13.0" w.c. ahead of valve with unit operating
Natural gas (regulated)	2.5" w.c. after gas valve with unit operating
LP gas (regulated)	8.5" w.c. after gas valve with unit operating

NOTE: Regulated gas pressures listed above are nominal and will vary depending on the installed orifice and various other factors. Use combustion (CO_2) analysis to determine proper firing. Gas pressures listed are starting points only.

16.1.1.3. TEMPERATURE READINGS

Flue gas maximum temperatures:	240°F
Operating limit switch operation:	160-180°F Open on rise
Auxiliary limit switch:	190°F Open on rise
Excess temp. switch (flue gas)	200°F Open on rise

NOTE: Flue gas temperature readings should be taken by inserting the temperature probe through the same hole used to take CO_2 readings after the boiler has been running for at least fifteen minutes and has reached normal operating temperatures.

16.1.1.4. AIR PRESSURE READINGS

Combustion air pressure switches monitor proper air flow through the system for proper combustion by reacting to the differential pressure across the intake air orifice. Any obstruction to air flow, either upstream or downstream from the combustion air blower will cause the differential across the orifice to approach zero. Measure differential pressures by connecting both legs of a U-tube manometer to the tubes leading to the combustion air pressure switch. Take readings with the combustion air blower running with and without the unit fired.

The flue gas pressure switch reacts to an increase in the combustion chamber pressure to avoid blowing the water seal out of the condensate trap and spilling products of combustion into the occupied space.

Minimum differential press.	3.5" w.c. differential (GB040)
	3.5" w.c. differential (GB060)
	1.1" w.c. differential (GB090)
	5.0" w.c. differential (GB130/GB160)
Maximum flue gas pressure	6.0" w.c. switch opens on pressure rise (all models)

16.1.1.5. WATER PRESSURE READINGS

The water pressure switch is intended to prevent firing of the boiler with no water in the system by sensing a minimum water pressure of 6 pounds per square inch. Most systems will be operated at pressures at or above 12 psi and the boiler and all connected components are rated for working pressures up to 100 psi according to A.S.M.E. test procedures. Note that the water pressure switch is not capable of differentiating between water and air pressure. If the piping is tested by pressurizing with air, be certain that the boiler does not fire until filled with water. Rapid failure of the heat exchanger will occur if dry-fired and resulting damage is not covered under warranty.

16.2. DEALER PARTS STOCKING

The following list suggests a parts selection and appropriate quantities of repair parts which should be stocked by the dealer to cover emergency replacements.

Stocking levels are for new dealers and should be adjusted according to the number and types of units the dealer has installed or intends to install. The suggested parts inventory includes many items which are industry standard and may already be contained in the dealer's parts inventory. Items below marked with an asterisk (*) are available only through GlowCore distributors and are not off-the-shelf products.

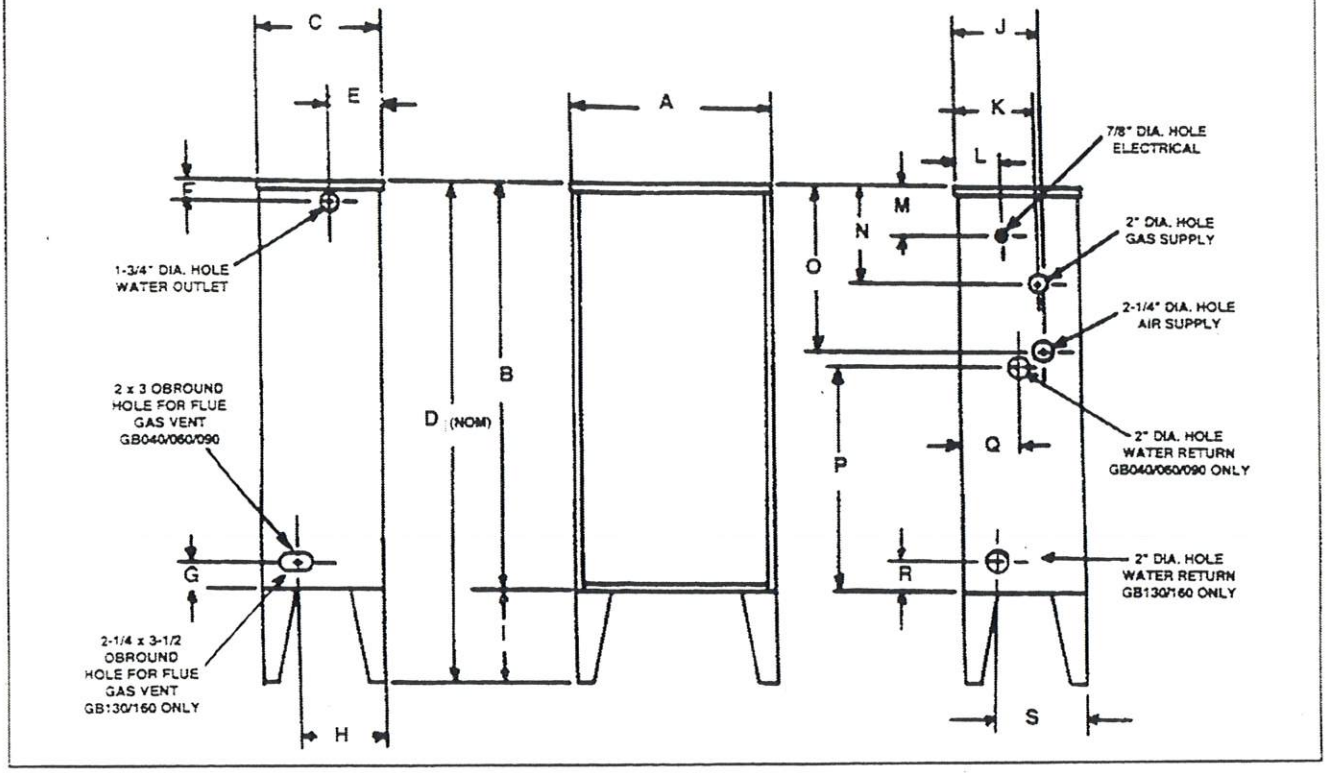
17. DIMENSIONS

Dimensional information is provided in the following section for all current GlowCore equipment.

17.1. GB BOILER DIMENSIONS

DIMENSIONAL DATA

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
GB040/060/090	18	36	11	44	3-5/8	2-7/8	1-1/2	7-7/8	8	9-1/16	8-15/16	4	4-3/16	9-1/2	16-3/4	18-3/4	5-3/4	—	—
GB130/160	21-1/8	42-1/8	11	50-1/8	4	2-3/4	1-11/16	6-1/2	8	9-3/4	9-1/2	4	9"	14	22-1/2	—	—	2-1/4	7-7/16

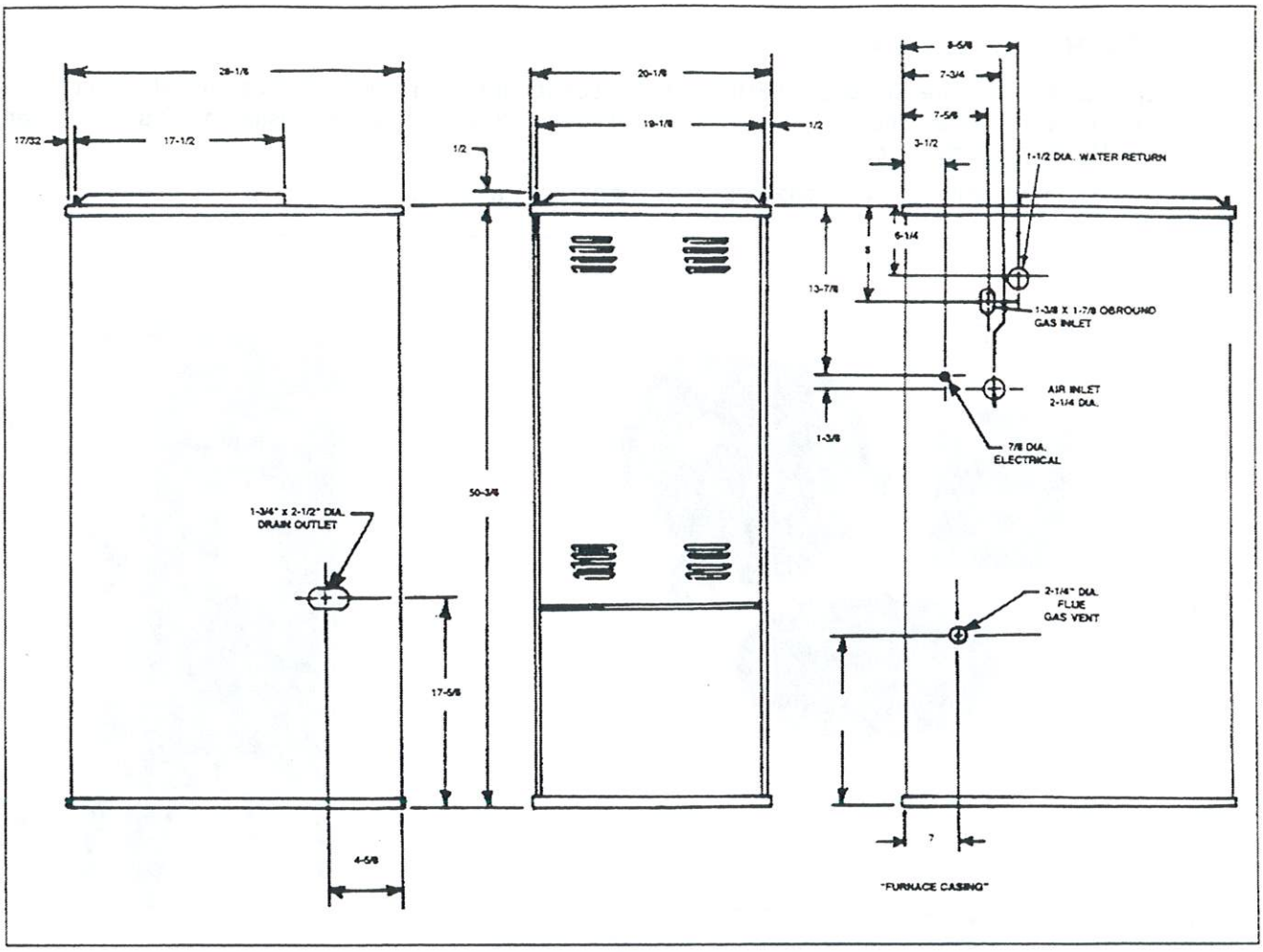


17.2. UF FURNACE DIMENSIONS

DIMENSIONS

MODEL	CABINET SIZE IN. WIDTH	DEPTH	HEIGHT	VENT DIA. IN.	GAS PIPE DIA. IN.	* MAX. VENT LENGTH FT.	*MAX. INTAKE AIR LENGTH FT.	SHIP WT. LBS.
UF 060	20	28	50	2	1/2	25	25	225
UF 080	20	28	50	2	1/2	25	25	235

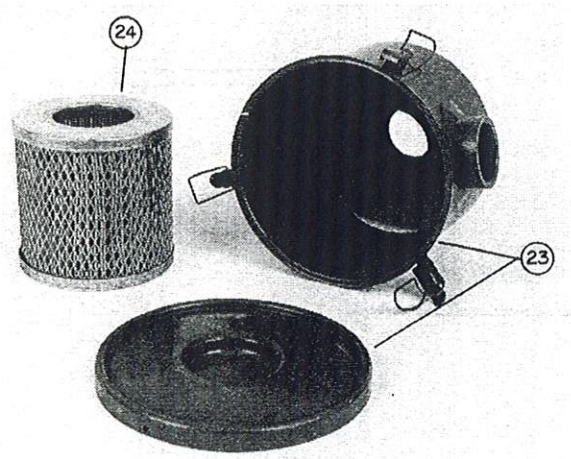
*LENGTHS ARE FEET PLUS 6 ELBOWS

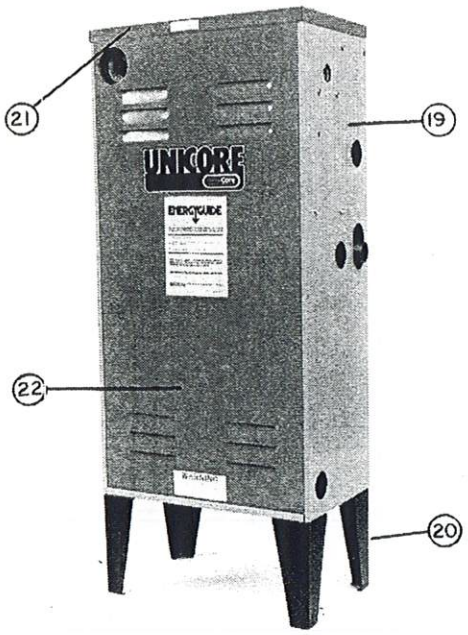

28-1/8
17/32
17-1/2
1/2
20-1/8
19-1/8
1/2
8-5/8
7-3/4
7-5/8
3-1/2
1-1/2 DIA. WATER RETURN
6-1/4
13-7/8
1-3/8 X 1-7/8 OBROUND GAS INLET
AIR INLET 2-1/4 DIA.
1-3/8
7/8 DIA. ELECTRICAL
50-3/8
1-3/4" x 2-1/2" DIA. DRAIN OUTLET
17-5/8
2-1/4" DIA. FLUE GAS VENT
4-5/8
7
"FURNACE CASING"

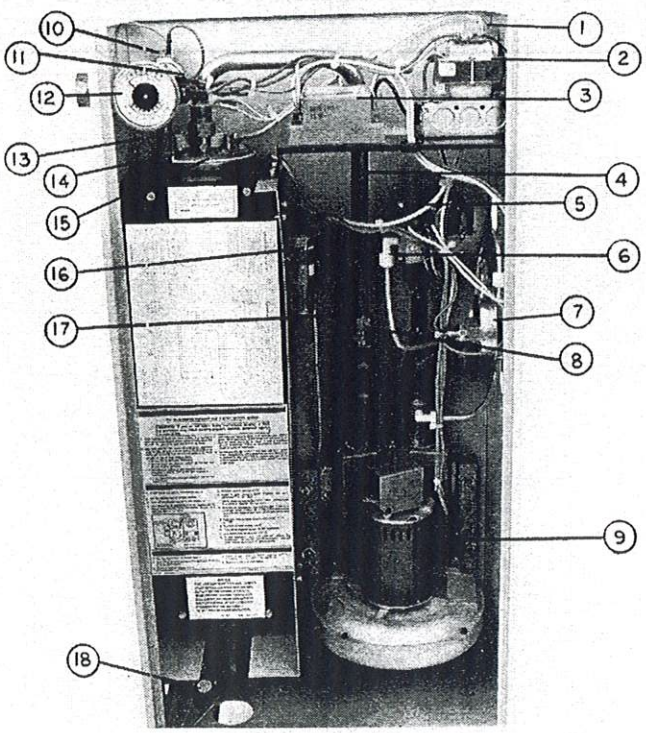
18. BOILER PARTS DIAGRAMS

Boiler parts diagrams are provided in the following section for all past and present boiler models. Check the rating plate of the boiler for "Service Code" designation. No service code designation is listed in this section if parts are standard for all production models.

18.1. GB0407, GB0607 AND GB0907 EXPLODED PARTS DIAGRAM





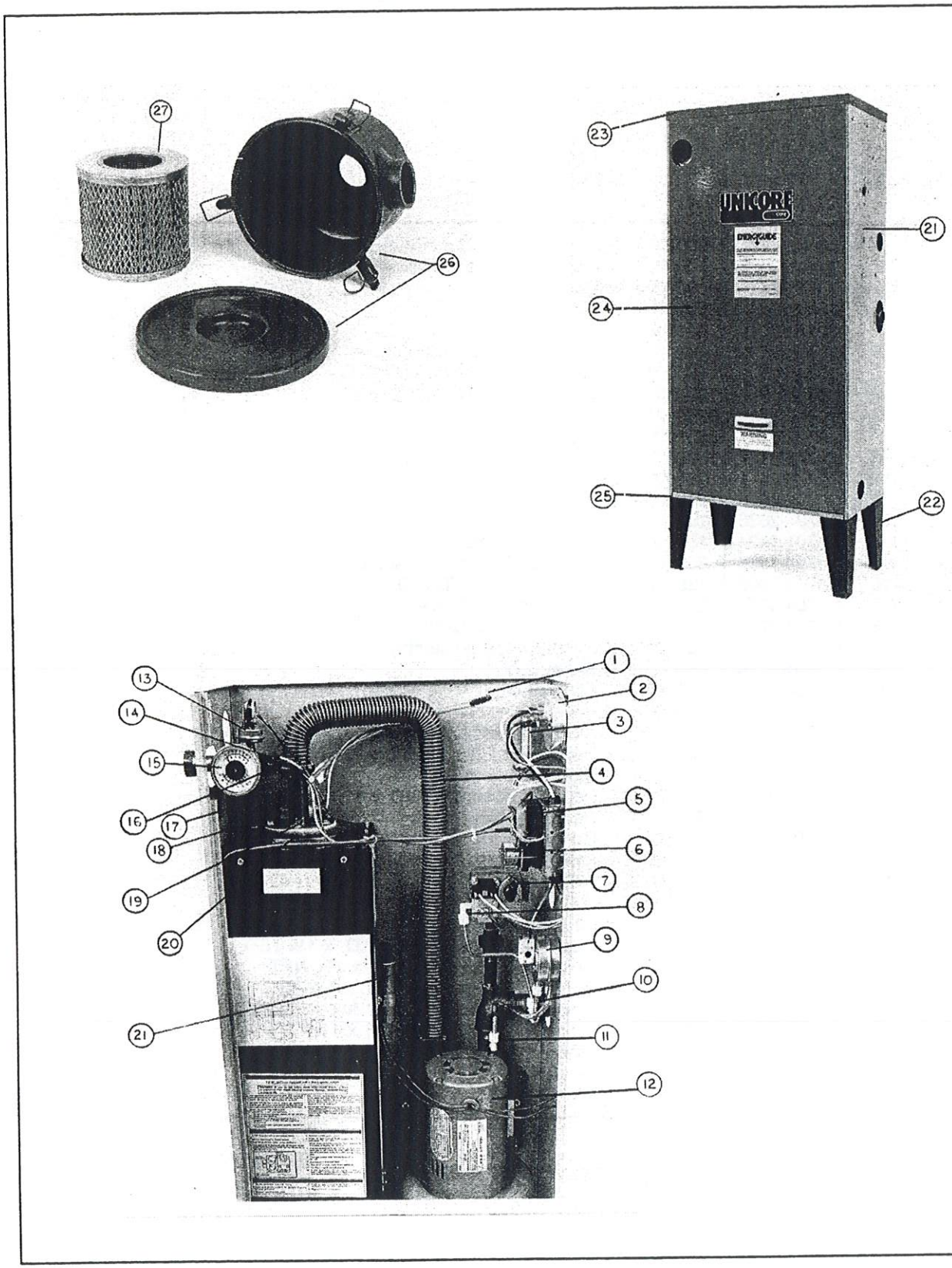


18.2. GB0407, GB0607 AND GB0907 REPLACEMENT PARTS LIST

REF. NO.	PART NO. OLD	PART NO. NEW	DESCRIPTION	GB0407	GB0607	GB0907
1	704-2727	2100023	Pressure Switch 7.5" WC	1	1	1
2	704-2602	2250002	Transformer Assembly	1	1	1
3	704-2624	1950000	Ignition Control	1	1	1
4	704-3735	2850007	Gas/Air Pipe	1	1	1
5	704-3500	1750002	Gas Valve	1	1	1
6	704-3835	3000014	Male Compression & Elbow	2	2	2
7	704-2715	2100015	Air Pressure Switch 4.0" WC	1	1	
7	704-2712	2100014	Air Pressure Switch 1.1" WC			1
8	704-3726	2820013	Compression Nut	2	2	2
9	704-5704	1050004	Combustion Air Blower	1	1	1
10	704-2731	2100033	Water Pressure Switch	1	1	1
11	704-2702	2100008	Operating Limit Switch	1	1	1
12	704-4600	2100034	Pressure/Temp. Gauge	1	1	1
13	704-2625	1950001	Ignitor/Sensor Assembly	1	1	1
14	704-3424	1800001	Burner Assembly	1	1	1
15	704-1554	2550000	Boiler Coil Welded Assembly	1	1	1
16	704-2608	1350003	Capacitor 15 MFD 370 V.	1	1	1
17	704-3727	2820014	Compression Sleeve	2	2	2
18	704-2717	2100016	Excess Temp. Switch	1	1	1
19	704-1520	5500007	Boiler Casing Assembly	1	1	1
20	704-0024	4500024	Boiler Leg	4	4	4
21	704-0030	4500030	Top Panel	1	1	1
22	704-0032	4500032	Boiler Front Panel	1	1	1
23	704-5370	1850002	Air Filter Assembly/Filter	1	1	1
24	704-5369	1850001	Replacement Filter Cartridge	1	1	1
*25	704-2701	2100007	High Limit Switch	1	1	1
*26	704-3827	3000011	Reducer Bushing 2" PVC x 1" NPT	1	1	1
*27	704-3876	3000028	Restrictor Orifice	1	1	1
*28	704-1023	4010002	Burner Screws #10-32 x ½ Lg.	6	6	6
*29	704-1004	4010000	Ignitor Screws #10-32 x 7/8" Lg.	2	2	2
*30	704-1952	2500027	#38 Gas Orifice	1		
*31	704-1949	2500056	#30 Gas Orifice		1	
*32	704-1946	2500053	#9 Gas Orifice			1
*33	704-1912	2500001	Suction Air Orifice 7/16" I.D. x 1¼ NPT	1		
*34	704-1916	2500003	Suction Air Orifice ½ I.D. x 1¼ NPT		1	
*35	704-1915	2500002	Suction Air Orifice 7/8 I.D. x 1¼ NPT			1
*36	704-1910	2500000	Discharge Air Orifice 3/8" I.D. x 1¼ NPT	1		
*37	704-1912	2500001	Discharge Air Orifice 7/16 x 1¼ NPT		1	
*38	704-1917	2500004	Discharge Air Orifice 9/16 x 1¼ NPT			1
*39	704-2706	2000000	Relay DPST	1	1	1
*40	704-3702	2700013	Sight Glass	1	1	1

* = Not Shown
NOTE: WHEN ORDERING PARTS, USE NEW PART NUMBERS.

18.3. GB13010 AND GB16014 EXPLODED PARTS DIAGRAM



18.4. GB13010 AND GB16014 REPLACEMENT PARTS LIST

REF. NO.	PART NO. OLD	PART NO. NEW	DESCRIPTION	GB130	GB160
1	704-3876	3000028	Restrictor Orifice	1	1
2	704-2727	2100023	Pressure Switch 7.5" WC	1	1
3	704-2624	1950000	Ignition Control	1	1
4	704-3920	3050007	Gas/Air Pipe	1	1
5	704-2602	2250002	Transformer Assembly	1	1
6	704-2706	200000	Relay—DPST	1	1
7	704-3500	1750002	Gas Valve	1	1
8	704-3835	3000014	Male Compression and Elbow	2	2
9	704-2733	2100029	Air Pressure Switch 5.0" WC	1	1
10	704-3836	3000015	Male Tee	1	1
12	704-5717	1050005	Combustion Air Blower	1	1
13	704-2731	2100033	Water Pressure Switch	1	1
14	704-2722	2100018	High Limit Switch	1	1
15	704-4600	2100034	Pressure—Temp Gauge	1	1
16	704-2723	2100019	Operating Limit Switch	1	1
17	704-3425	1800002	Burner Assembly	1	1
18	704-2626	1950006	Hot Surface Ignitor	1	1
19	704-3702	2700013	Sight Glass	1	1
20	704-1591	2550002	Boiler Coil Welded Assembly	1	1
21	704-2608	1350003	Capacitor 15 MFD 370 V	1	1
22	704-0024	4500024	Boiler Leg	4	4
23	704-0127	4500127	Top Panel	1	1
24	704-0130	5500008	Boiler Casing Assembly	1	1
25	704-1594	4500130	Boiler Front Panel	1	1
26	704-5370	1850002	Air Filter Assembly with Filter	1	1
27	704-5369	1850001	Replacement Filter Cartridge	1	1
*28	704-2117	1500012	Ignitor Gasket	1	1
*29	704-2116	1500011	Burner Gasket	1	1
*30	704-1004	4010000	Ignitor Screws 10-32 x ½ Lg.	2	2
*31	704-2107	1500007	Gas/Air Manifold Gasket (Cork)	2	2
*32	704-1939	1800005	Mounting Flange, Gas/Air Manifold	4	4
*33	704-1023	4010002	Screw, Gas/Air Manifold & Burner	14	14
*34	704-1915	2500002	Air Intake Orifice 7/8" ID		1
*35	704-1991	2500008	Air Intake Orifice 3/4" ID	1	
*36	704-1991	2500008	Air Discharge Orifice 3/4" ID	1	
*37	704-1967	2500042	Nat. Gas Orifice #2 DMS		1
*38	704-1955	2500030	Nat. Gas Orifice #11 DMS	1	
*39	704-2717	2100016	Excess Temp. Limit	1	1

* = Not Shown

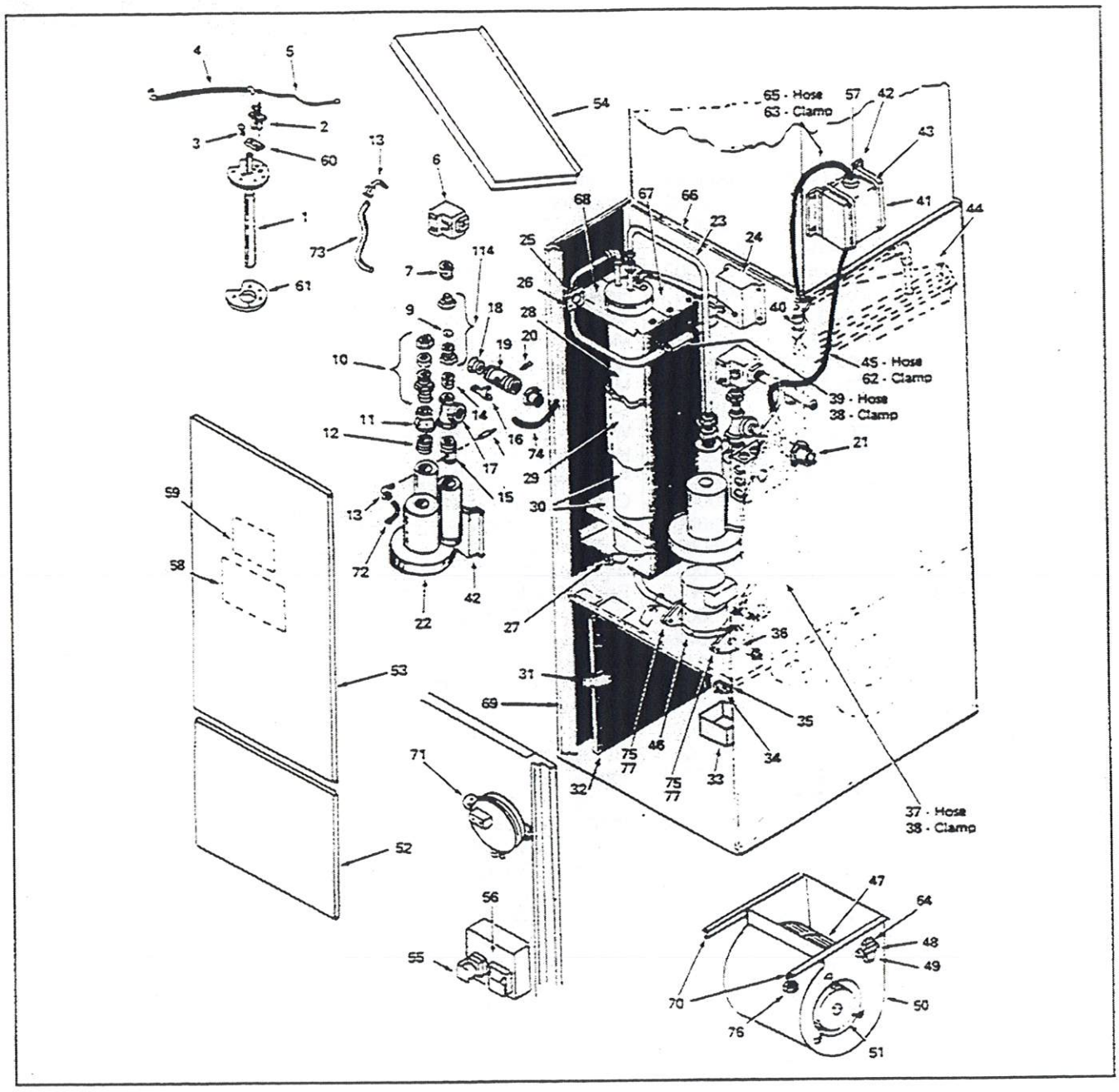
NOTE: WHEN ORDERING PARTS, USE THE NEW PART NUMBERS!

19. UF FURNACE PARTS DIAGRAMS

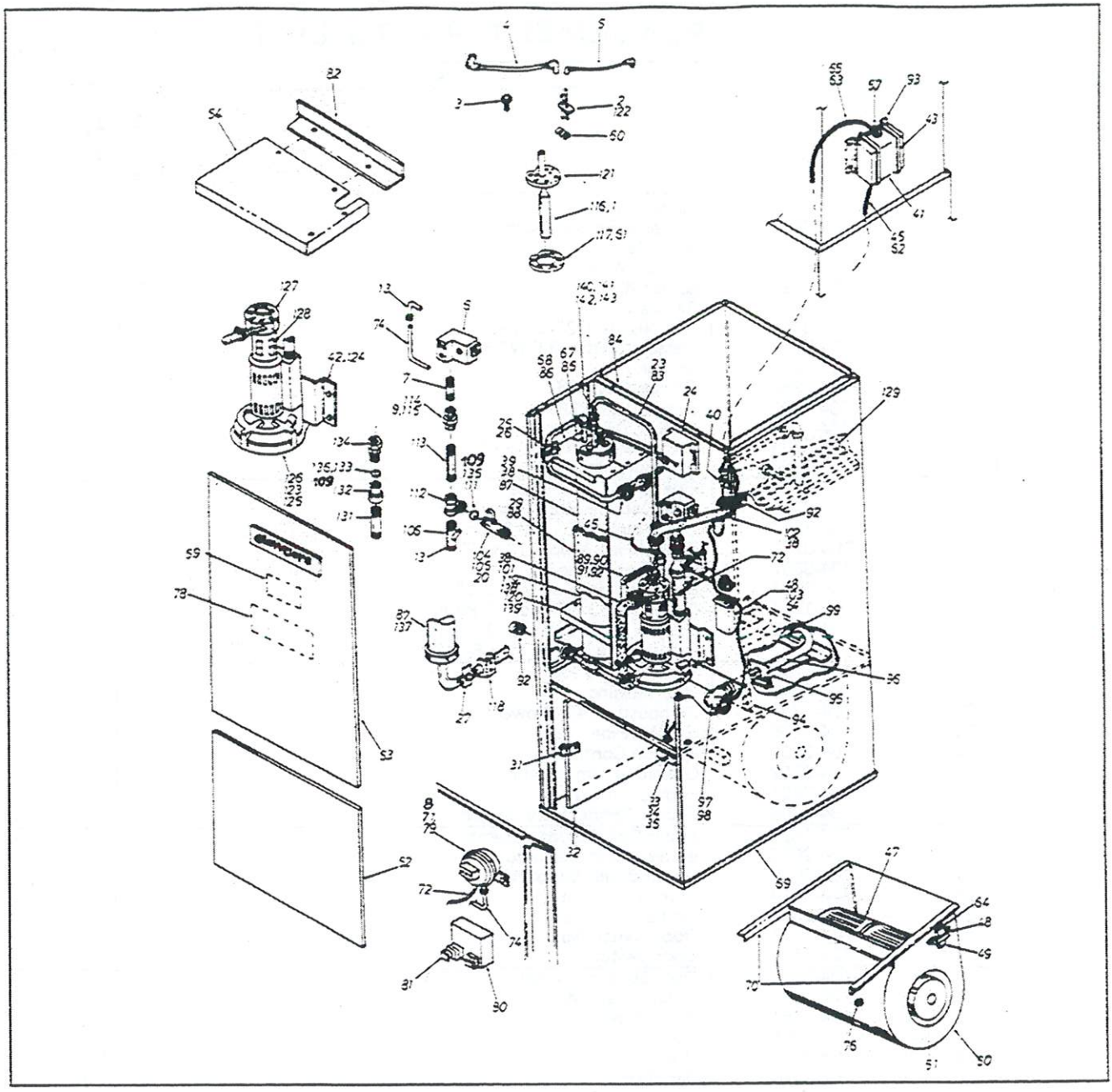
Furnace parts diagrams are provided in the following section for all past and present boiler models. Check the rating plate of the furnace for "Service Code" designation. No service code designation is listed in this section if parts are standard for all production models.

19.1. UF FURNACE EXPLODED PARTS DIAGRAM--SERVICE CODE 1

UF040D14



UF040D14R, UF060D14R, UF080D14R



19.2. UF FURNACE REPLACEMENT PARTS LIST–SERVICE CODE 1

REPLACEMENT PARTS LIST

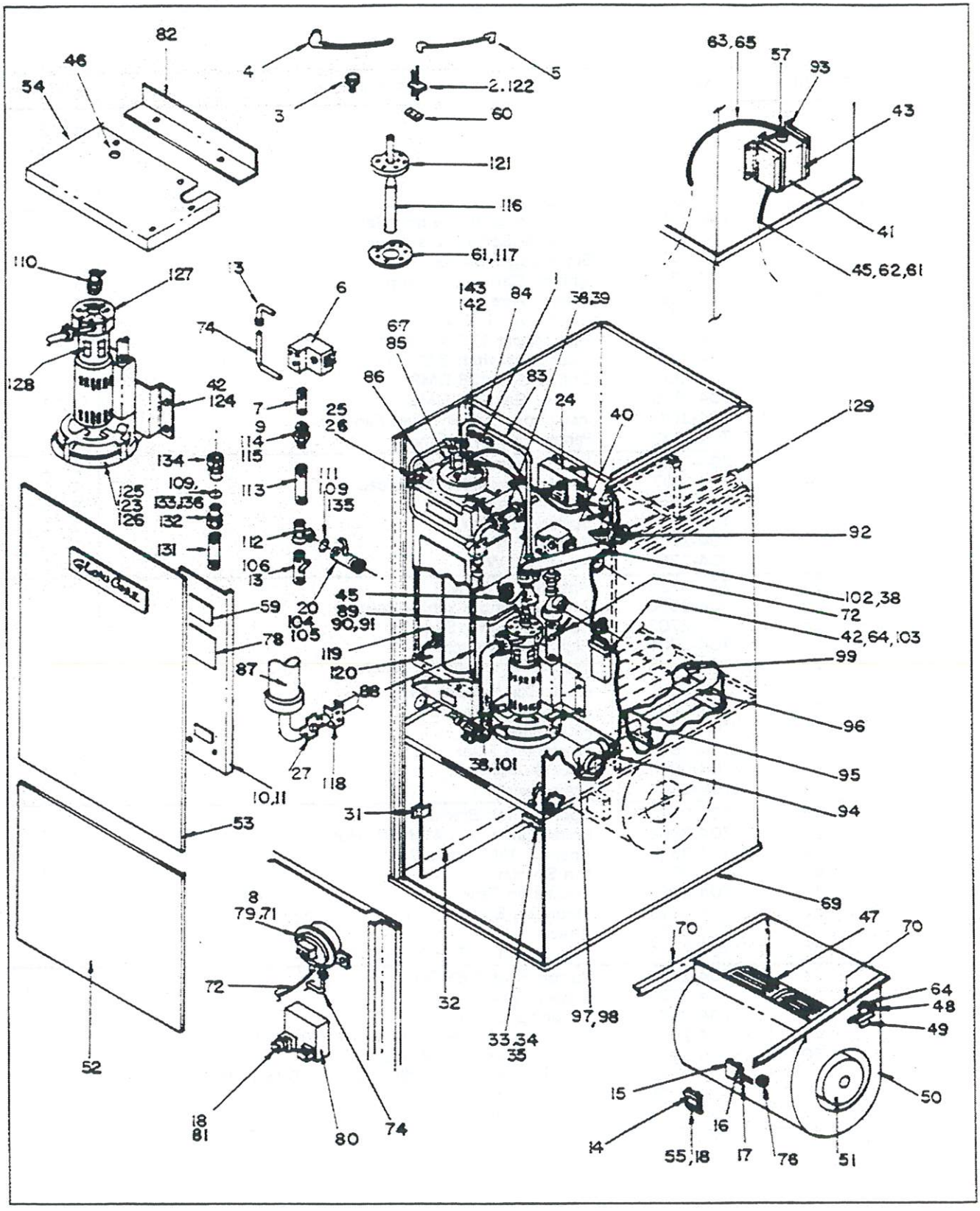
MODEL NOS.

REF. NO.	PART NO.	DESCRIPTION	QUANTITY				
			UF040D14R	UF060D14R	UF080D14R		UF040D14
1	704-3416	Burner Assembly (4" Dia. Boiler)	1				1
2	704-2600	Igniter & Sensor Assembly	1	1	1		1
3	704-3702	Sight Gage	1	1	1		1
4	704-2604	Ignition Wire	1	1	1		1
5	704-3023	Sensor Wire	1	1	1		1
6	704-3500	Gas Valve	1	1	1		1
7	704-3710	Pipe Nipple 1/2" x close	1	1	1		1
8	704-2715	Pressure Switch 3.5 WC		1			
9	704-1951	Orifice,					1
	704-1950	Orifice, Gas #28		1			
	704-1952	Orifice, Gas #38	1				
	704-1945	Orifice, Gas #10			1		
10	704-3704	Compression Fitting 3/4"					1
11	704-3703	Pipe Reducer 3/4" x 1"					1
12	704-3712	Pipe Nipple 1" x close					1
13	704-3835	Male Compression Elbow	2	2	2		2
14	704-3711	Pipe Nipple 1/2" x 1-1/2"					1
15	704-3720	Special Pipe Nipple 1" x 3"					1
16	704-3837	Male Branch Tee					1
17	704-3701	Reducer Tee 1" x 1/2" x 1"					1
18	704-1911	Orifice, Air 3/8" (For 1" Pipe)					1
	704-1913	Orifice, Air 7/16" (For 1" Pipe)					1
19	704-3722	Special Pipe Nipple 1" x 5-1/2"					1
20	704-3725	Pipe Plug 1/8" NPT	2	2	2		2
21	704-3810	PVC Bushing					2
22	704-5702	Combustion Air Blower					1
23	704-3705	Gas/Air Pipe	1				1
24	704-2601	Ignition Control	1	1	1		1
25	704-2702	Operating Limit Switch	1	1	1		1
26	704-2701	High Limit Switch	1	1	1		1
27	704-2708	Excess Temperature Switch	1	1	1		1
28	704-1523	Boiler Coil Welded Assembly	1				1
29	704-2026	Boiler Jacket Insulation	1				1
30	704-0026	Lower Boiler Support	1				1
31	704-0014	Front Filter Clip	1	1	1		1
32	704-2010	Permanent Filter	1	1	1		1
33	704-0011	Door Switch Box	1	1	1		1
34	704-2704	Door Switch	1	1	1		1
35	704-0013	Door Switch Bracket	1	1	1		1
36	704-4205	Return Water & Drain					1
37	704-3851	Water Hose					1
38	704-3808	Hose Clamp	6	6	6		6
39	704-3850	Hose	1	1	1		1
40	704-2703	Fan Switch	1	1	1		1
41	704-3860	Expansion Tank	1	1	1		1
42	704-0012	Mounting Bracket	1	1	1		1
43	726-0153	Strap	2	2	2		2
44	704-1519	Warm Air Coil	1	1	1		1
45	704-3852	Water Hose 3/8" I.D.	1	1	1		1
46	704-5200	Water Circulator Pump					1
47	704-5701	Blower Wheel	1	1	1		1
48	704-2505	Capacitor Strap	2	2	2		2
49	704-2603	Capacitor 10 MFD 370 Volt	1	1	1		1
50	704-5700	Blower Housing w/Wheel	1	1	1		1
51	704-5100	Direct Drive Motor	1	1	1		1
52	704-0009	Blower Door	1	1	1		1
53	704-0008	Burner & Control Door	1	1	1		1

REF. NO.	PART NO.	DESCRIPTION	QUANTITY				
			UF040D14R	UF060D14F	UF080D14R		UF140D14
54	704-0010	Top Panel	1	1	1		1
55	704-2705	Relay 24 Volt Coil DPST					1
56	704-1536	Transformer Assembly 115/24 Vac					1
57	704-3861	Expansion Tank Cap	1	1	1		1
58	704-7301	Wiring Diagram					1
59	704-7711	Lighting Instructions	1	1	1		1
60	704-2100	Electrode Gasket	1	1	1		1
61	704-2101	Glowcore 4" Gasket	1				1
62	704-3807	Hose Clamp	2	2	2		2
63	704-3809	Hose Clamp	2	2	2		2
64	704-2502	Capacitor Boot	2	2	2		2
65	704-3802	Water Hose 1/4" I.D.	1	1	1		1
66	704-1529	Heat Exchanger Partition S/W ASM					1
67	704-0027	Upper Rear Boiler Support 4" Dia.	1				1
68	704-0028	Upper Front Boiler Support	1				1
69	704-1521	Furnace Casing ASM	1	1	1		1
70	704-0018	Blower Mtg. Angle	2	2	2		2
71	704-2700	Pressure Switch 2.0 WC	1				1
72	704-3853	Tube, Vinyl	1	1	1		1
73	704-3855	Tube, Alum, 7" Lg.	1	1	1		1
74	704-3856	Tube, Alum, 9" Lg.	2	2	2		
75	704-5201	Pump Flange Kit w/Gasket					2
76	704-5703	Rubber Grommet	4	4	4		4
77	704-5202	Gasket, Water Pump					2
78	704-7305	Wiring Diagram	1	1	1		
79	704-2710	Pressure Switch .7 WC			1		
80	704-1517	Transformer Ass'y.	1	1	1		
81	704-2706	Relay SPST.	1	1	1		
82	704-0054	Angle, Duct Flange	1	1	1		1
83	704-3735	Gas Air Pipe	1	1	1		
84	704-1532	Heat Exchanger Partition Ass'y.	1	1	1		
85	704-0048	Upper Rear Boiler Support 5" Dia.		1	1		
86	704-0049	Upper Front Boiler Support 5" Dia.		1	1		
87	704-1548	Boiler Coil Welded Ass'y. 5" Dia.		1	1		
88	704-2028	Boiler Jacket Insulation 5" Dia.		1	1		
89	704-7000	Installation Manual	1	1	1		1
90	704-7001	Owners Manual	1	1	1		1
91	704-7002	Replacement Parts Manual	1	1	1		1
92	704-3706	Pipe Plug (Drain)	2	2	2		2
93	704-0059	Bracket Expansion Tank	1	1	1		1
94	704-0050	Panel, Recuperator Tube Access	1	1	1		
95	704-0053	Plate, Recuperator Tube	2	2	2		
96	704-5506	Serpentine Coil, Recuperator	1	1	1		
97	704-3822	Elbow 90° PVC 1-1/4"	1	1	1		
98	704-3817	Bushing, PVC Special	1	1	1		
99	704-2503	Strap - Nylon	2	2	2		2
100	704-7003	Envelope, Manual	1	1	1		1
101	704-3829	Hose, Water Pump-Outlet	1	1	1		
102	704-3818	Hose, Water Pump-Inlet	1	1	1		
103	704 2608	Capacitor 15 MFD 370 Volt	1	1	1		
104	704-3836	Male Run Tee	1	1	1		
105	704-3723	Nipple 1-1/4" N.P.T. x 5-1/4" Lg.	1	1	1		
106	704-3724	Nipple 1-1/4" N.P.T. x 4" Lg. Special 1/8 Tap	1	1	1		
107	704-3716	Nipple 1-1/4" N.P.T. x 4" Lg.	1	1	1		
108	704-3729	Reducer Coupling 1" x 1-1/4"	1	1	1		
109	704-1912	Air Orifice 7/16" I.D.	1	1			
110							

REF. NO.	PART NO.	DESCRIPTION	QUANTITY				
			UF040D14R	UF060D14R	UF080D14R		UF040D14
111	704-1915	Air Orifice 7/8" I.D.			1		
112	704-3730	Reducer Tee 1-1/4" x 1/2" x 1-1/4"	1	1	1		
113	704-3717	Pipe Nipple 1/2" N.P.T. x 3" Lg.	1	1	1		
114	704-3731	Union, Conical Joint 1/2" N.P.T.	1	1	1		1
115							
116	704-3415	Burner Ass'y. 5" (Boiler)		1	1		
117	704-2104	Glowcore Gasket 5" Dia.		1	1		
118	704-3811	Clamp, Muffler Type	1	1	1		
119	704-1556	5" Dia. Boiler Support Spotweld Ass'y.		1	1		
120	704-0058	Support 5" Boiler Lower Front		1	1		
121	704-1023	Screw Hex HD (#10-32 x 1/2" Lg.)	6	6	6		
122	704-1022	Screw #4-40 x 1/2 Lg.	2	2	2		2
123	704-0294	Screw Hex Hd. Cap #1/4-20 x 3/8 Lg.	4	4	4		4
124	704-0751	Screw Hex Hd. Cap. #1/4-20 x 5/8 Lg.	4	4	4		4
125	736-0222	Lock Washer, Internal 1/4	8	8	8		8
126	704-5704	Blower, Comb. Air	1	1	1		
127	704-5203	Water Pump - Magnetic Drive	1	1	1		
128	1501-030	Screw Hex Hd. Cap. #8-32 x 5/8 Lg.	4	4	4		
129	704-1550	Warm Air Coil Ass'y.	1	1	1		1
130	704-1912	Orifice, Air 7/16"	1	1			
131	704-3716	Nipple, 1-1/4" N.P.T. x 4" Lg.	1	1	1		
132	704-3729	Reducer, Pipe (1" x 1-1/4")	1	1	1		
133	704-1918	Air Orifice .625 I.D.			1		
134	704-3728	Fitting, Compression 7/8" O.D. Tube	1	1	1		
	704-7000	Installation Insturctions (UF040 & UF060)					
	704-7001	Owners Manual (UF040 & UF060)					
	704-7011	Installation Instructions (UF080 & UF060R)		1	1		
	704-7012	Owners Manual (UF080 & UF060R)		1	1		
	704-7029	Insert for Model (UF040D14)					1
135	704-1917	Air Orifice 9/16" I.D.		1			
136	704-1910	Air Orifice 3/8" I.D.	1				
137	704-1547	Boiler Coil Welded Ass'y. 4" Dia.	1				
138	704-1555	4" Dia. Boiler Supt. S/W Ass'y.	1				1
139	704-0057	4" Dia. Boiler Supt. Lower Front	1				1
140	704-3707	Sleeve-5/8" Comp. Fitting	1				1
141	704-3708	Nut-5/8" Comp. Fitting	1				1
142	704-3727	Sleeve 3/4" Comp. Fitting		1	1		
143	704-3726	Nut 3/4" Comp. Fitting		1	1		

19.3. UF FURNACE EXPLODED PARTS DIAGRAM--SERVICE CODE 3



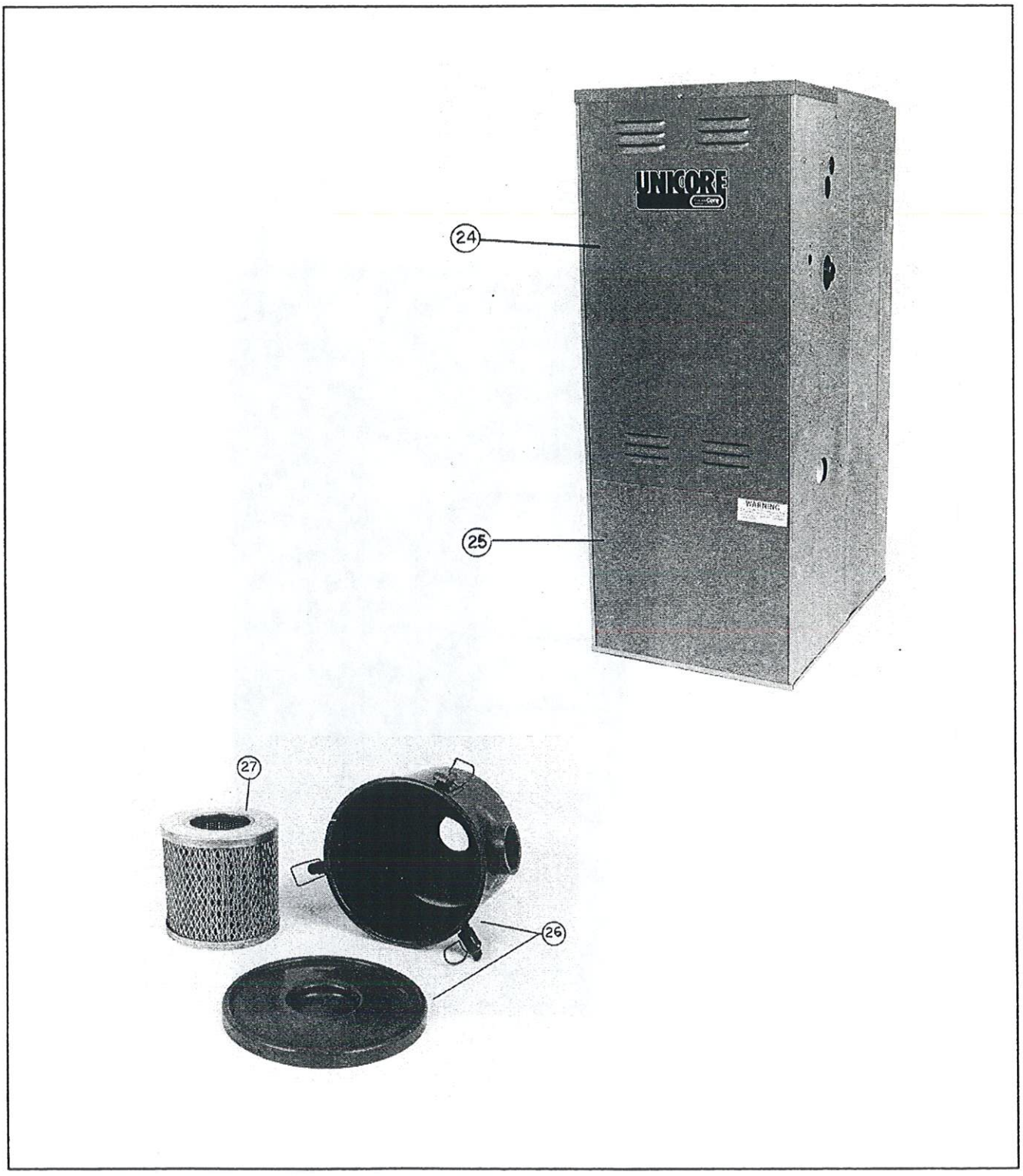
19.4. UF FURNACE REPLACEMENT PARTS LIST–SERVICE CODE 3

REF. NO	PART NO.	DESCRIPTION	QUANTITY		
			UF060D14R	UF080D14R	
1	704-2730	Water Pressure Switch- Set 2 PSIG	1	1	
2	704-2600	Igniter & Sensor Assembly	1	1	
3	704-3702	Sight Gage- Burner	1	1	
4	704-2616	Ignition Cable- 14" Long	1	1	
5	704-3023	Sensor Wire	1	1	
6	704-3500	Gas Valve- 1/2" x 1/2"	1	1	
7	704-3710	Pipe Nipple 1/2" x close	1	1	
8	704-2715	Pressure Switch 3.5" WC	1		
9	704-1950	Orifice Gas #28 DMS	1		
	704-1945	Orifice Gas #10 DMS		1	
10	704-2044	Insulation—Boiler Cover Panel	1	1	
11	704-0133	Panel—UF Boiler Cover	1	1	
13	704-3835	Male Compression Elbow	2	2	
14	704-1607	4 x 4 J-Box Cover w/Recept.	1	1	
15	704-2552	Bushing-Star	3	3	
16	704-2554	Bushing SR-7W	2	2	
17	704-2551	Bushing SR-8P	2	2	
18	704-2714	Relay Bail Wire	2	2	
20	704-3725	Pipe Plug 1/8" NPT	2	2	
24	704-2620	Ignition Control White Rodgers	1	1	
25	704-2702	Operating Limit Switch	1	1	
26	704-2701	High Limit Switch	1	1	
27	704-2708	Excess Temperature Switch	1	1	
28	704-1523	Boiler Coil Welded Assembly			
30	704-0026	Lower Boiler Support			
31	704-0014	Front Filter Clip	1	1	
32	704-2010	Permanent Filter	1	1	
33	704-0011	Door Switch Box	1	1	
34	704-2704	Door Switch	1	1	
35	704-0013	Door Switch Bracket	1	1	
38	704-3808	Hose Clamp- 1 1/4" Nom. Hose	6	6	
39	704-3850	Hose- 1 1/4" Nom. O.D.	1	1	
40	704-2703	Fan Switch	1	1	
41	704-3863	Expansion Tank	1	1	
42	704-0012	Mounting Bracket	1	1	
43	726-0153	Strap	2	2	
45	704-3852	Water Hose 3/8" I.D.- 5/8" Nom. O.D.	1	1	
46	704-2566	Button Plug 7/8" Dia.	1	1	
47	704-5701	Blower Wheel	1	1	
48	704-2505	Capacitor Strap	2	2	
49	704-2603	Capacitor 10 MFD 370 Volt- Circulating Blower	1	1	
50	704-5700	Blower Housing w/Wheel	1	1	
51	704-5100	Direct Drive Motor- PSC 1/2 H.P. 1075 RPM	1	1	
52	704-0009	Blower Door	1	1	
53	704-0008	Burner & Control Door	1	1	

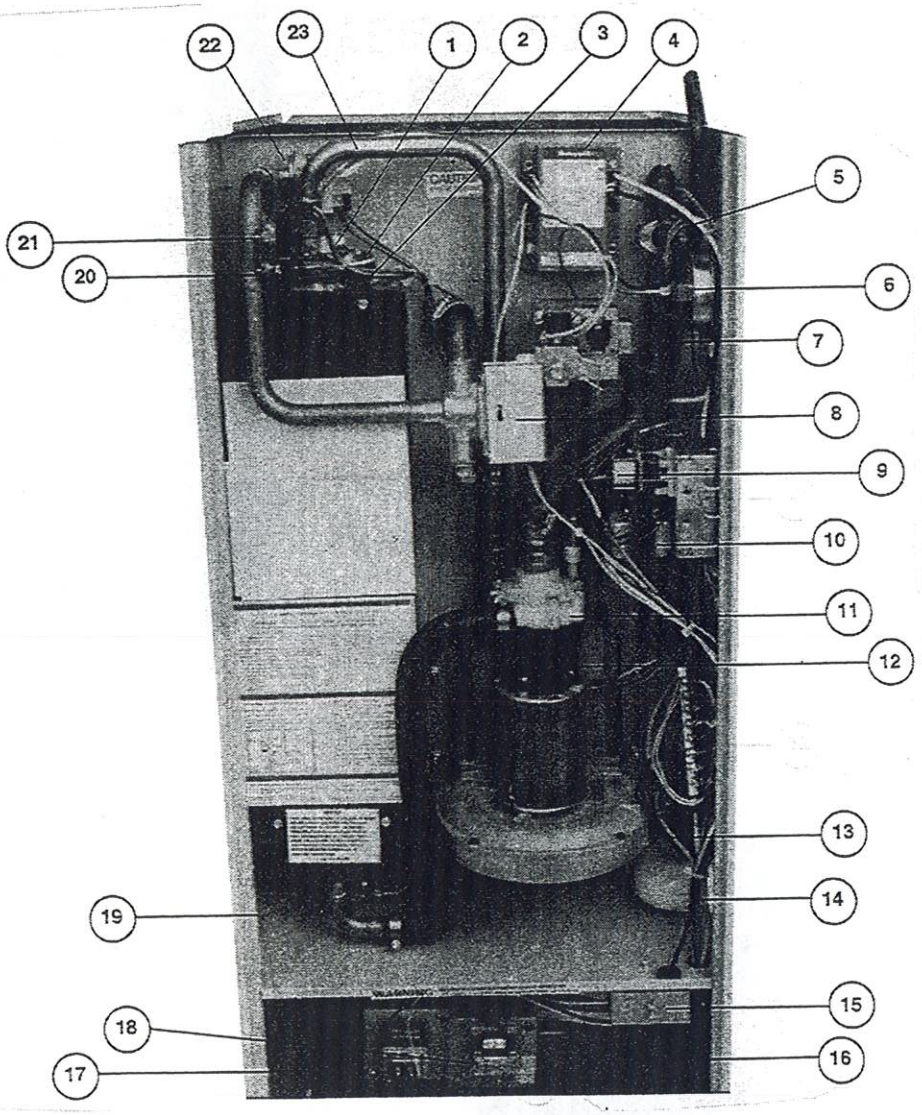
REF. NO.	PART NO.	DESCRIPTON	QUANTITY		
			UFO80D14R	UFO80D14R	
54	704-1608	Top Panel Assembly	1	1	
55	704-2716	Relay 24 Volt Coil SPDT- Cooling Relay	1	1	
57	704-3861	Expansion Tank Cap	1	1	
59	704-7756	Lignting Instructions	1	1	
60	704-2100	Gasket Igniter	1	1	
61	704-3838	Fitting Hose. Barb- 1/4" MPT (Brass)	1	1	
62	704-3807	Hose Clamp- 5/8" Nom. O.D.	2	2	
63	704-3809	Hose Clamp- Vinyl Tube Exp. Tank 3/8" O.D.	1	1	
64	704-2502	Capacitor Boot	2	2	
65	704-3802	Water Hose 1/4" I.D.- Vinyl 3/8" O.D.	1	1	
69	704-1521	Furnace Casing ASM	1	1	
70	704-0018	Blower Mtg. Angle	2	2	
72	704-3853	Tube. Vinyl- 1/4" I.D. x 3/8" O.D.	1	1	
73	704-3855	Tube. Alum. 7" Lg. 1/4" O.D.	1	1	
74	704-3856	Tube. Alum. 9" Lg. 1/4" O.D.	2	2	
76	704-5703	Rubber Grommet	4	4	
78	704-7326	Wiring Diagram Serivce Code 3	1	1	
79	704-2710	Pressure Switch .7" WC		1	
80	704-1517	Transformer Ass'y.	1	1	
81	704-2705	Relay DPST- Combustion Air Blower	1	1	
82	704-0054	Angle. Duct Flange	1	1	
83	704-3735	Gas Air Pipe	1	1	
84	704-1532	Heat Exchanger Partition Ass'y.	1	1	
85	704-0048	Upper Rear Boiler Support 5" Dia.	1	1	
86	704-0049	Upper Front Boiler Support 5" Dia.	1	1	
87	704-1548	Boiler Coil Welded Ass'y. 5" Dia.	1	1	
88	704-2028	Insulation Boiler Compartment	1	1	
91	704-7096	Replacement Parts Manual	1	1	
92	704-3706	Pipe Plug (Drain)	1	1	
93	704-0059	Bracket Expansion Tank	1	1	
94	704-0050	Panel. Recuperator Tube Access	1	1	
95	704-0053	Plate. Recuperator Tube	2	2	
96	704-5506	Serpentine Coil Recuperator	1	1	
97	704-3814	Elbow 90° PVC 1-1/2"	1	1	
98	704-3834	Bushing, PVC Special 1-1/2"	1	1	
99	704-2503	Strap - Nylon	2	2	
100	704-7003	Envelopes. Manual	1	1	
101	704-3829	Hose Water Pump-Outlet- 1 1/4" Nom. O.D.	1	1	
102	704-3818	Hose. Water Pump-Inlet- 1 1/4" Nom. O.D.	1	1	
103	704-2606	Capacitor 12.5 MFD 370 Volt- Combustion Air Blower	1	1	
104	704-3836	Male Run Tee	1	1	
105	704-3723	Nipple 1-1/4" N.P.T. x 5-1/4" Lg.	1	1	
106	704-3724	Nipple 1-1/4" N.P.T. x 4" Lg. Special 1/8" Tap	1	1	
107	704-3716	Nipple 1-1/4" N.P.T. x 4" Lg.	1	1	

REF. NO.	PART NO.	DESCRIPTION	QUANTITY		
			UFO60D14R	UFO80D14R	
108	704-3729	Reducer Coupling 1" x 1-1/4"	1	1	
109	704-1912	Air Orifice 7/16" I.D. (Outlet)	1		
110	704-4217	Manifold—Water Inlet Ass'y.	1	1	
111	704-1915	Air Orifice 7/8" I.D. (Inlet)		1	
112	704-3730	Reducer Tee 1-1/4" x 1/2" x 1-1/4"	1	1	
113	704-3717	Pipe Nipple 1/2" N.P.T. x 3" Lg.	1	1	
114	704-3731	Union, Conical Joint 1/2" N.P.T.	1	1	
116	704-3415	Burner Ass'y. 5" (Boiler)	1	1	
117	704-2104	GlowCore Gasket 5" Dia.	1	1	
118	704-3811	Clamp, Muffler Type	1	1	
119	704-1556	5" Dia. Boiler Support Spotweld Ass'y.	1	1	
120	704-0058	Support 5" Boiler Lower Front	1	1	
121	704-1023	Screw Hex HD (#10-32 x 1/2 Lg.)	6	6	
122	704-1024	Screw 6-32 x 3/8" Lg.	2	2	
123	704-0294	Screw Hex Hd. Cap #1/4-20 x 3/8 Lg.	4	4	
124	704-0751	Screw Hex Cap #1/4-20 x 5/8 Lg.	4	4	
125	704-0222	Lock Washer, Internal 1/4	8	8	
126	704-5704	Blower, Comb. Air	1	1	
127	704-5203	Water Pump — Magnetic Drive	1	1	
128	1501-030	Screw Hex Hd. Cap #8-32 x 5/8 Lg.	4	4	
129	704-5500	Warm Air Coil Ass'y.	1	1	
131	704-3716	Nipple, 1-1/4" N.P.T. x 4" Lg.	1	1	
132	704-3729	Reducer, Pipe (1" x 1-1/4")	1	1	
133	704-1918	Air Orifice 5/8" I.D. (Outlet)		1	
134	704-3728	Fitting, Compression 7/8" O.D. Tube	1	1	
	704-7011	Installation Instructions	1	1	
	704-7012	User's Manual	1	1	
135	704-1917	Air Orifice 9/16" I.D. (Inlet)	1		
142	704-3727	Sleeve 3/4" Comp.	1	1	
143	704-3726	Nut 3/4" Comp Fitting	1	1	

19.5. FURNACE EXPLODED PARTS DIAGRAM--SERVICE CODE 4



19.6. UF FURNACE REPLACEMENT PARTS LIST--SERVICE CODE 4



REF. NO.	OLD PART NO.	NEW PART NO.	PART DESCRIPTION	UF 060	UF 080
1	704-2625	1950001	Igniter HSI	1	1
2	704-3424	1800001	Burner HSI	1	1
3	704-1548	2550001	Heat Exchanger	1	1
4	704-2624	1950000	Ignition Control HSI	1	1
5	704-2703	2100009	Fan Switch	1	1
6	704-2715	2100015	Air Pressure SW 3.5	1	
	704-2710	2100013	Air Pressure SW .7		1
7	704-3500	1750002	Gas Valve	1	1
8	704-4177	1650001	Diverter Valve	1	1
9	704-2705	2000000	Relay DPST	1	1
10	704-2602	2250002	Transformer Ass'y.	1	1
11	704-5203	1600003	Water Pump—Mag Drive	1	1
12	704-3829	3060005	Hose Pump Outlet	1	1
13	704-5704	1050004	Combustion Air Blower	1	1
14	704-3814	3000004	Elbow 90 PVC 1-1/2"	1	1
15	704-2704	2100010	Door Switch	1	1
16	704-5700	1050003	Blower Housing w/Wheel	1	1
17	704-2609	2250003	Transformer 24V	1	1
18	704-2706	2000001	Relay SPST	1	1
19	704-2708	2100012	Excess Temp. SW	1	1
20	704-2701	2100007	High Limit SW	1	1
21	704-2702	2100008	Operating Limit SW	1	1
22	704-2730	2100026	Water Pressure SW	1	1
23	704-3735	2850007	Gas Air Pipe SS	1	1
24	704-0008	4500008	Burner & Control Door	1	1
25	704-0009	4500009	Blower Door	1	1
26	704-5370	1850002	Inline Filter Ass'y.	1	1
27	704-5369	1850001	Element Inline Filter	1	1
*28	704-2115	1500010	Gasket 5" Burner HSI	1	1
*29	704-2117	1500012	Igniter Gasket HSI	1	1
*30	704-1023	4010002	Burner Screws	6	6
*31	704-1004	4010000	Igniter Screws HSI	2	2
*32	704-3702	2700013	Sight Glass Iron	1	1
*34	704-5100	1400002	Direct Drive Motor	1	1
*35	704-2603	1350000	Capacitor for 704-5100	1	1
*36	704-2606	1350001	Capacitor for 704-5704	1	1
*37	704-2727	2100023	SW Press Flue/Gas 7.5 WC	1	1
*38	704-1917	2500004	Orifice Suct. Air 9/16" ID	1	
*39	704-1912	2500001	Orifice Disc. Air 7/16" ID	1	
*40	704-1950	2500025	Orifice Nat. Gas #28	1	
*41	704-1915	2500002	Orifice Suct. Air 7/8" ID		1
*42	704-1918	2500005	Orifice Disc. Air 5/8" ID		1
*43	704-1942	2500049	Orifice Nat. Gas #13		1

*=NOT SHOWN

Note: When ordering parts, use new part numbers.

20. UNICORE AIR HANDLERS

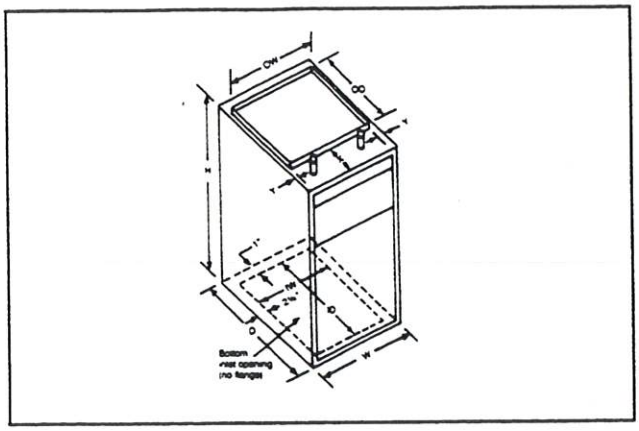
Unicore air handlers are available for a variety of warm air applications where zoned forced air heating is desired.

20.1. HWF SERIES--HEAT ONLY FAN COIL UNITS

HWF series units contain only the hot water coil for heating purposes. A-coils can be added for air conditioning if proper consideration is given to air flow with the added restriction to air flow created by the A-coil.

20.1.1. HWF SERIES DIMENSIONS

DIMENSIONS									
MODEL	H	W	D	OW	OD	IW	ID	X	Y
HWF 32-3	24¾	17⅜	20¼	12	16	13⅛	18⅛	3½	2½
HWF 52-4	25¼	21⅛	22¼	18	16	17⅛	20⅛	5¼	1½
HWF 60-4	28¾	21⅛	28¼	18	24	17⅛	26⅛	3¼	1⅝



20.1.2. HWF SERIES BLOWER DATA

BLOWER DATA							
MODEL	MOTOR AMPS (120V)	FAN SPEED	CFM vs. STATIC PRESSURE				
			0.1	0.2	0.3	0.4	0.5
HWF 32-3	6.5	HIGH	990	940	880	830	770
		LOW	920	870	820	770	710
HWF 52-4	6.5	HIGH	1350	1300	1230	1170	1090
		LOW	1170	1130	1090	1040	1000
HWF 60-4	8.5	HIGH	1780	1710	1640	1580	1510
		LOW	1080	1070	1050	1040	1020

20.1.3. HWF SERIES PERFORMANCE DATA

PERFORMANCE DATA						
MODEL	MAX. COOLING CAPACITY (TONS)	GPM (HEATING)	P.D. (FT. H_2O)	HEATING BTUH (1000)[3] AT ENT. WATER TEMP.		
				120°F	140°F	180°F[5]
HWF 32-3	2.0	3	5.0	22.9	32.0	50.3
		2	2.5	21.4	30.0	47.1
		1	0.8	16.8	23.5	36.9
HWF 52-4	2.5	5	3.8	40.0	55.8	87.7
		3	1.6	34.9	48.9	76.8
		1	0.25	20.7	29.0	45.6
HWF 60-4	3.5	6	2.85	47.9	67.0	105.2
		4	1.45	43.2	60.5	95.0
		2	0.40	34.6	48.5	76.2

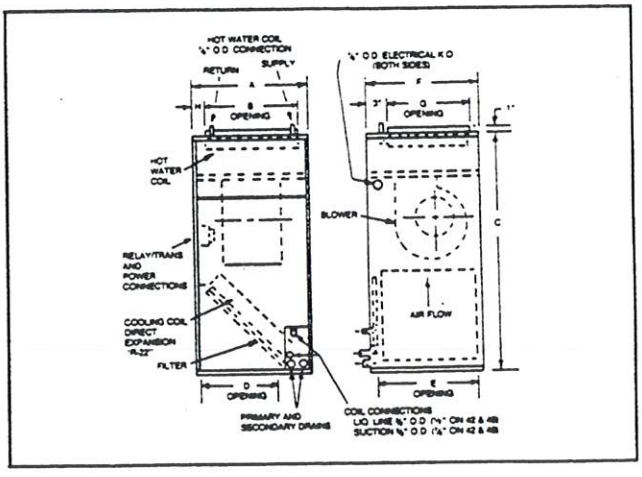
(1) Motors are 120V / 60 Hz.
(2) Units include fan relay, transformer and filter.
(3) Heating BTUH output is with 70° entering air temperature.
(4) Heating BTUH output will not exceed output of water heater.
(5) 180° capacities are for boiler applications only.

20.2. VDX SERIES HEAT/COOL FAN COIL UNITS

VDX series air handlers include cooling coils and warm air coils.

20.2.1. VDX SERIES DIMENSIONS

PHYSICAL DIMENSIONS									FILTER SIZE
MODEL	A	B	C	D	E	F	G	H	
24 VDX	14	12½	40	8¾	18	20	16	1	16x20x1
30 VDX 36 VDX	20	18	42	14½	18	20	16	1	20x20x1
42 VDX 48 VDX	21¼	18	48	15⅜	26⅛	28	24	1⅝	14x20x1 (2)



20.2.2. VDX SERIES BLOWER DATA

BLOWER DATA

MODEL	MOTOR AMPS (120V)	CFM vs. STATIC PRESSURE					
		0.05	0.10	0.20	0.30	0.40	0.50
24 VDX	6.5	950	935	900	850	800	725
30 VDX	6.5	1170	1140	1090	1020	950	880
36 VDX	8.5	1250	1230	1170	1100	1040	960
42 VDX	8.5	1750	1700	1620	1530	1440	1330
48 VDX	10.2	1920	1880	1820	1750	1680	1590

20.2.3. VDX SERIES PERFORMANCE DATA

PERFORMANCE DATA
3- AND 4-ROW HOT WATER COILS

	MODEL	NOM. COOL BTUH	GPM HEATING	P.D.	HEATING BTUH (1000) AT ENT. WATER TEMP.(3)		
					120°F	140°F	180°F
3-ROW	24VDX-3HW	24,000	3	5.0	22.3	31.2	49.0
			2	2.5	20.4	28.6	45.0
			1	0.8	16.3	22.9	36.0
	30VDX-3HW	30,000	5	4.6	32.5	44.5	71.5
			3	1.9	29.3	41.0	64.4
			1	0.27	20.0	28.0	44.0
	36VDX-3HW	36,000	5	4.6	34.3	48.0	75.4
			3	1.9	30.7	43.0	67.5
			1	0.27	20.3	28.5	44.7
4-ROW	42VDX-4HW	42,000	6	2.85	47.8	67.0	105.2
			4	1.45	43.2	60.5	95.0
			2	0.40	34.6	48.5	76.2
	48VDX-4HW	48,000	6	2.85	52.8	74.0	116.2
			4	1.45	47.8	67.0	105.2
			2	0.40	36.4	51.0	80.1

(1) Motors are 120V / 60 Hz.
(2) Units include cap tube / strainer assemblies, sweat connections, filter, and relay transformer.
(3) Heat BTUH at 70° entering air temperature.
(4) Heating output will not exceed output of water heater.
(5) Select capacities at either 3 or 4 GPM when "Flow Control" module is used.

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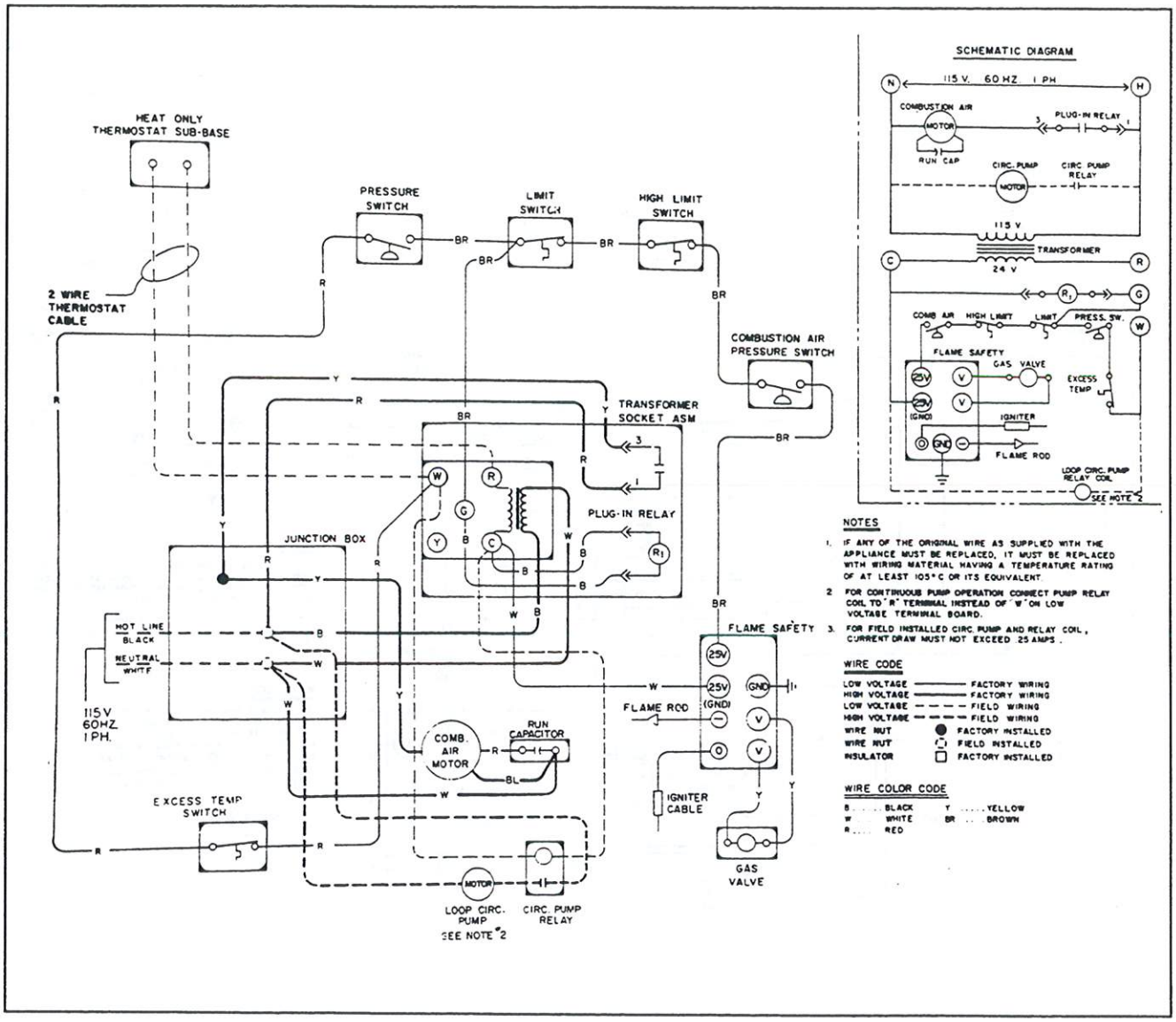
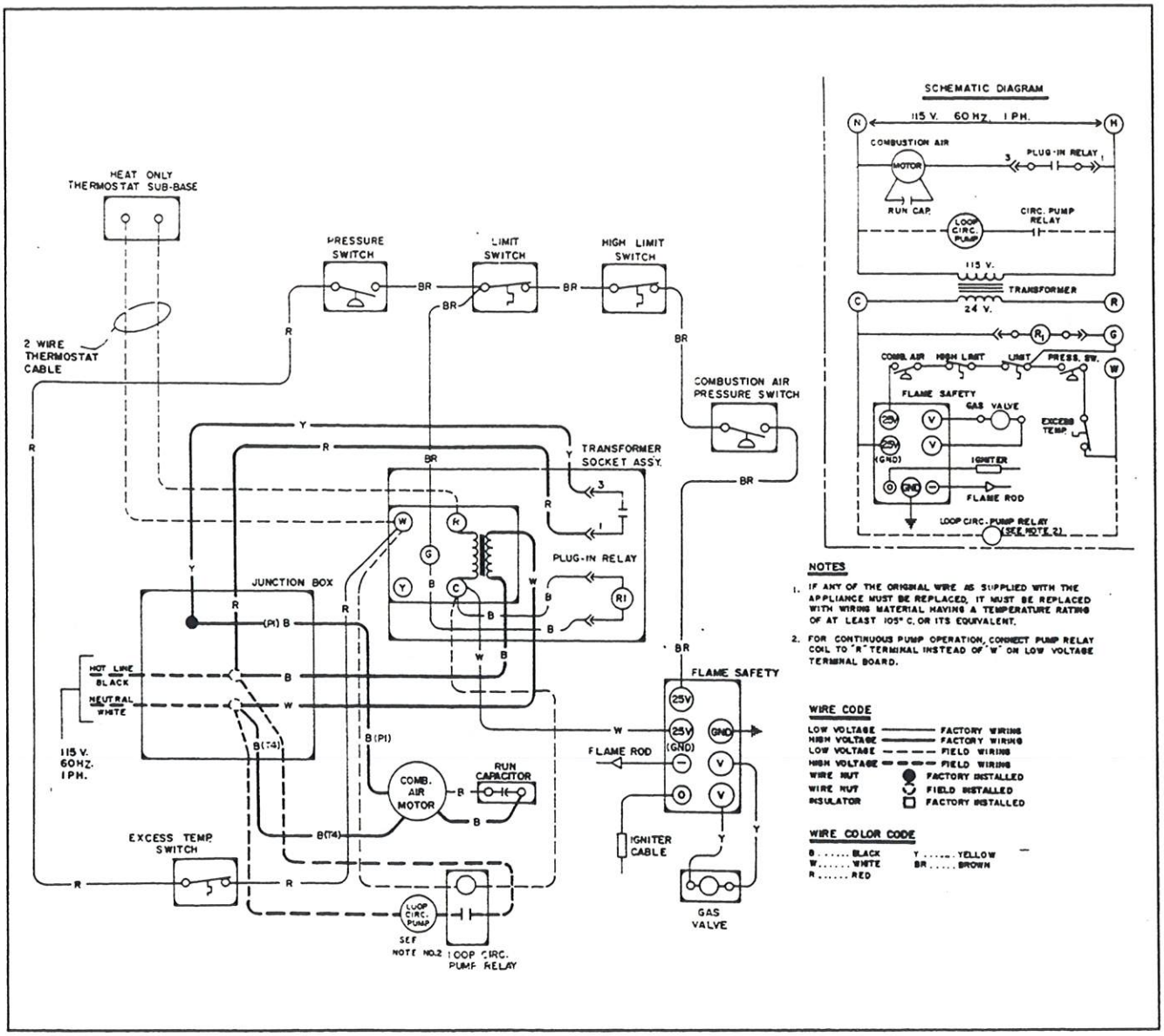
21. BOILER WIRING DIAGRAMS

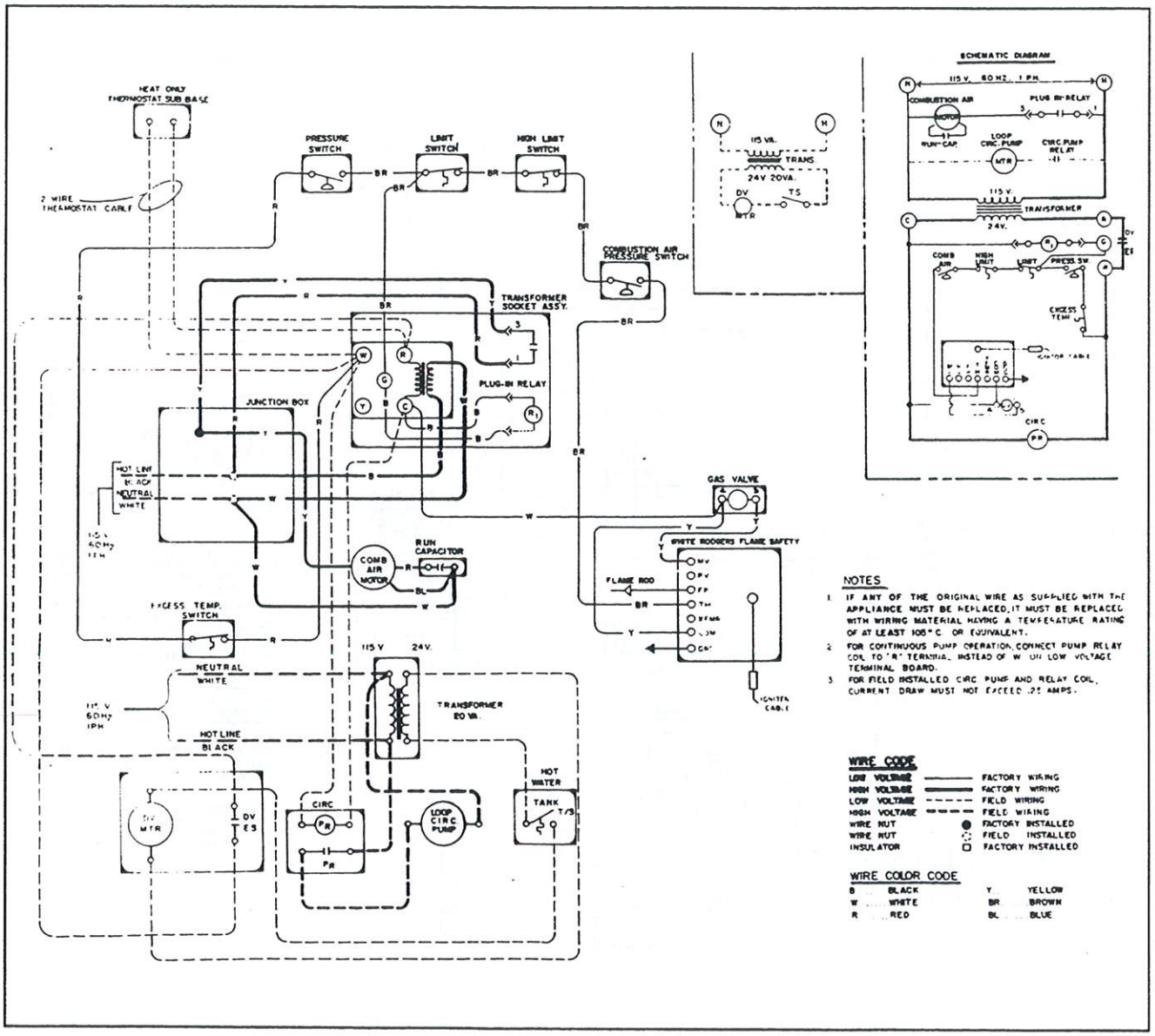
21.1. GB0607,GB0907 WITH HONEYWELL S87D SPARK IGNITION--SERVICE CODE 3



21.2. GB13010, GB16014 WITH HONEYWELL S87D SPARK IGNITION--SERVICE CODE 3



21.3. GB0607, GB0907 WITH WHITE-RODGERS 50D20 SPARK IGNITION--SERVICE CODE 3



NOTES

1. IF ANY OF THE ORIGINAL WIRE AS SUPPLIED WITH THE APPLIANCE MUST BE REPLACED, IT MUST BE REPLACED WITH WIRING MATERIAL HAVING A TEMPERATURE RATING OF AT LEAST 105° C OR EQUIVALENT.
2. FOR CONTINUOUS PUMP OPERATION, CONNECT PUMP RELAY COIL TO "R" TERMINAL INSTEAD OF W ON LOW VOLTAGE TERMINAL BOARD.
3. FOR FIELD INSTALLED CIRC PUMP AND RELAY COIL, CURRENT DRAW MUST NOT EXCEED .25 AMPS.

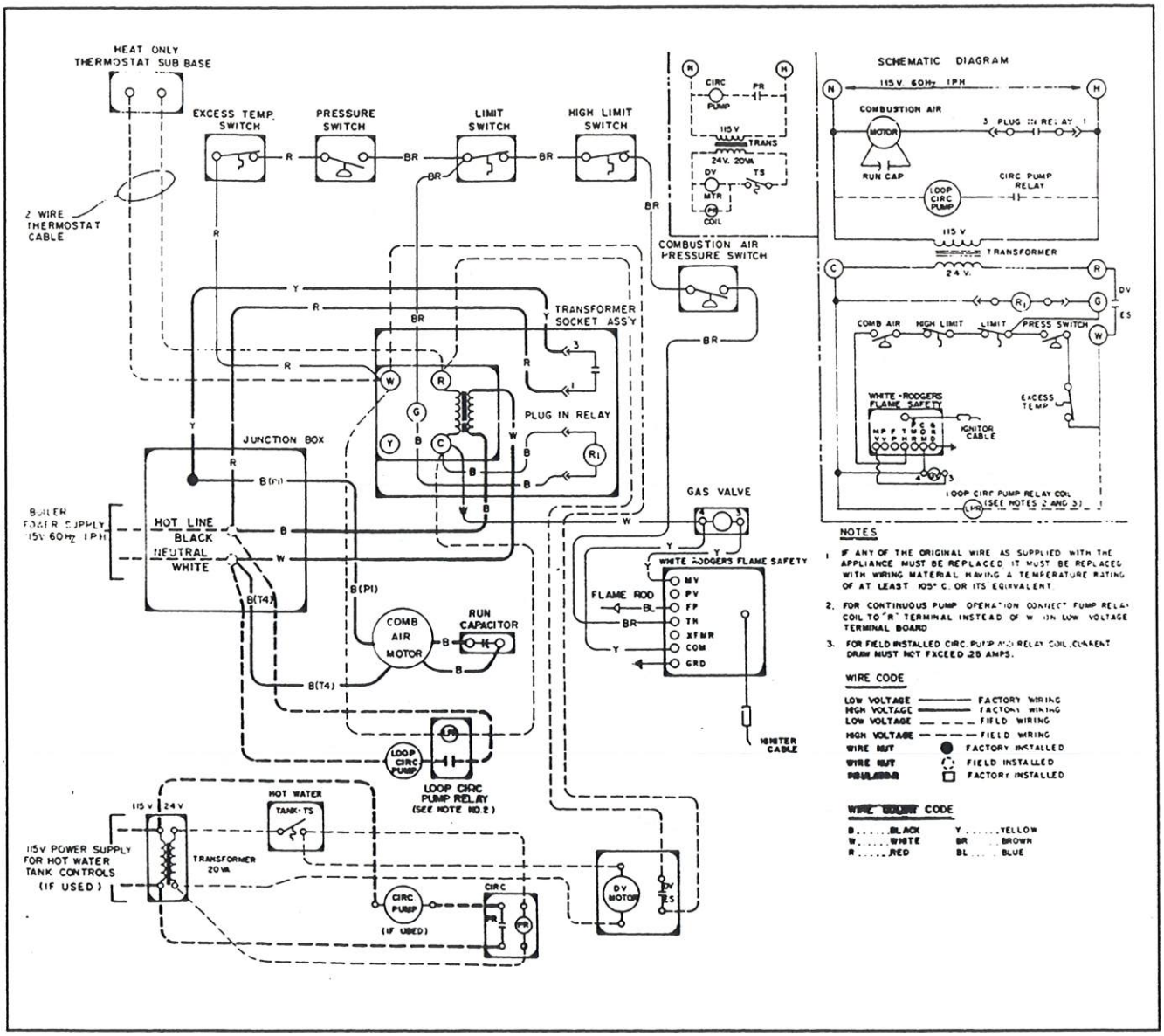
WIRE CODE

LOW VOLTAGE	———	FACTORY WIRING
HIGH VOLTAGE	———	FACTORY WIRING
LOW VOLTAGE	- - -	FIELD WIRING
HIGH VOLTAGE	- - -	FIELD WIRING
WIRE NUT	●	FACTORY INSTALLED
WIRE NUT	◌	FIELD INSTALLED
INSULATOR	□	FACTORY INSTALLED

WIRE COLOR CODE

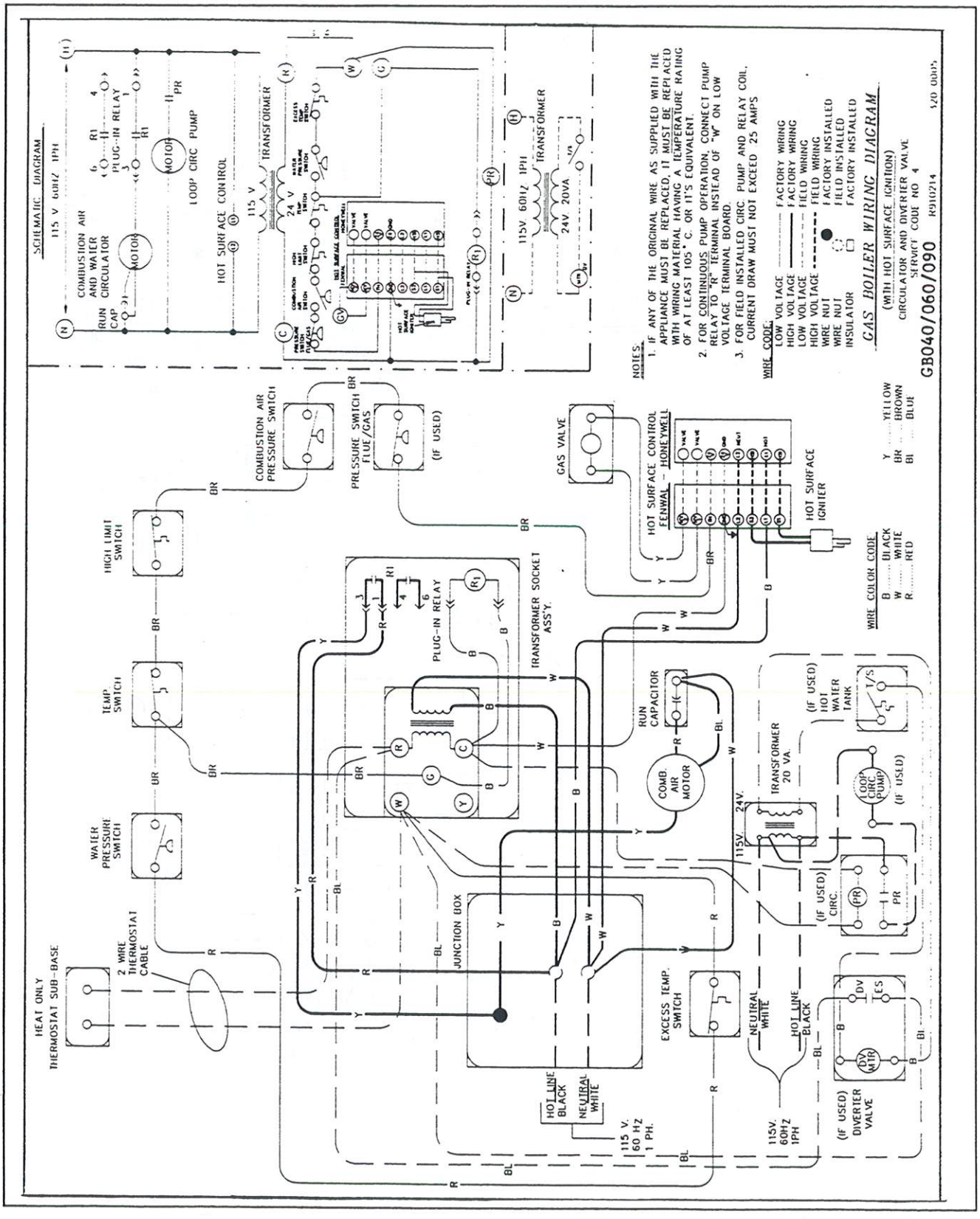
B	BLACK	Y	YELLOW
W	WHITE	BR	BROWN
R	RED	BL	BLUE

21.4. GB13010, GB16014 WITH WHITE-RODGERS 50D20 SPARK IGNITION--SERVICE CODE 3



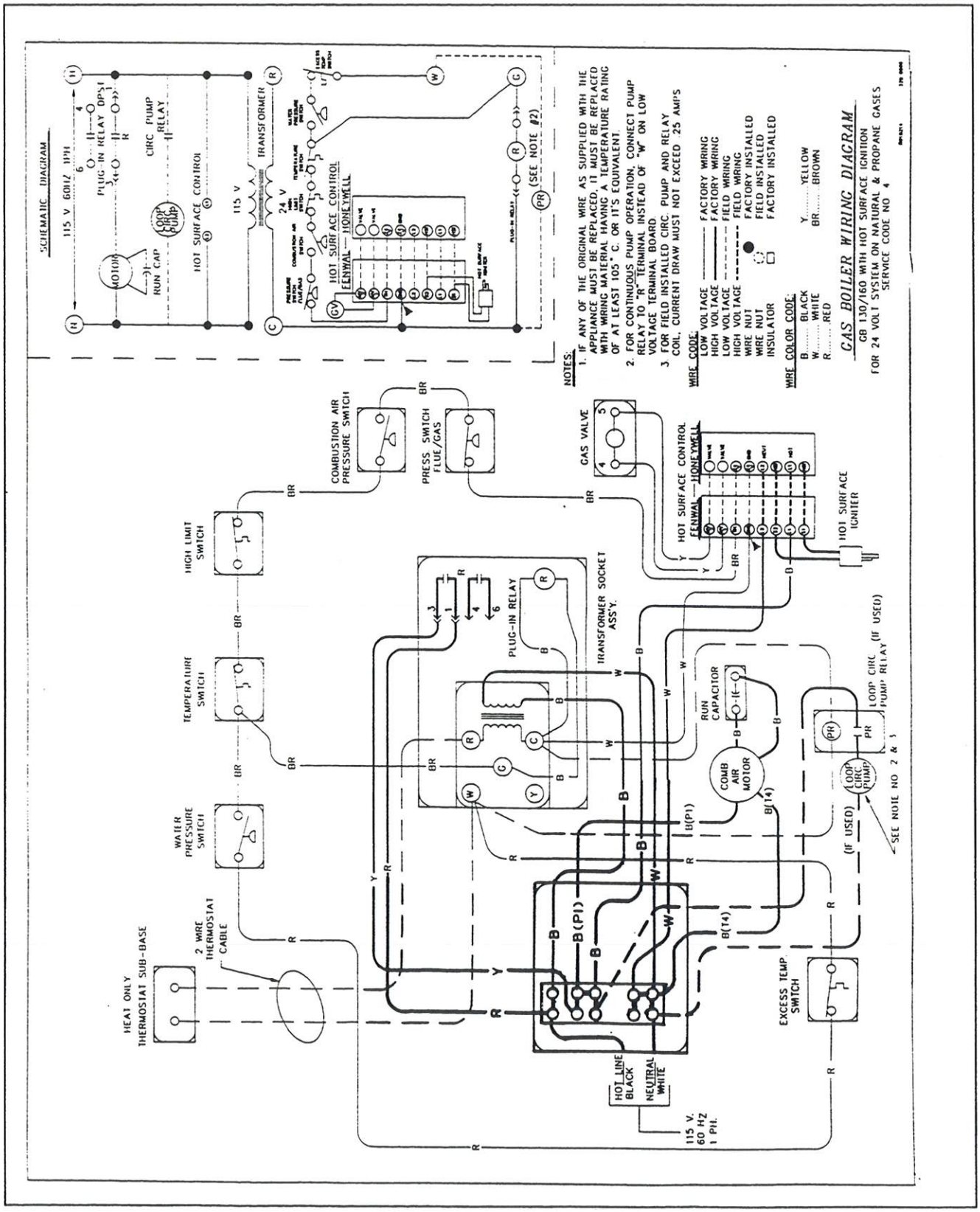
21.5. GB0607,GB0907 WITH HONEYWELL OR FENWAL HOT SURFACE IGNITION

SERVICE CODE 4



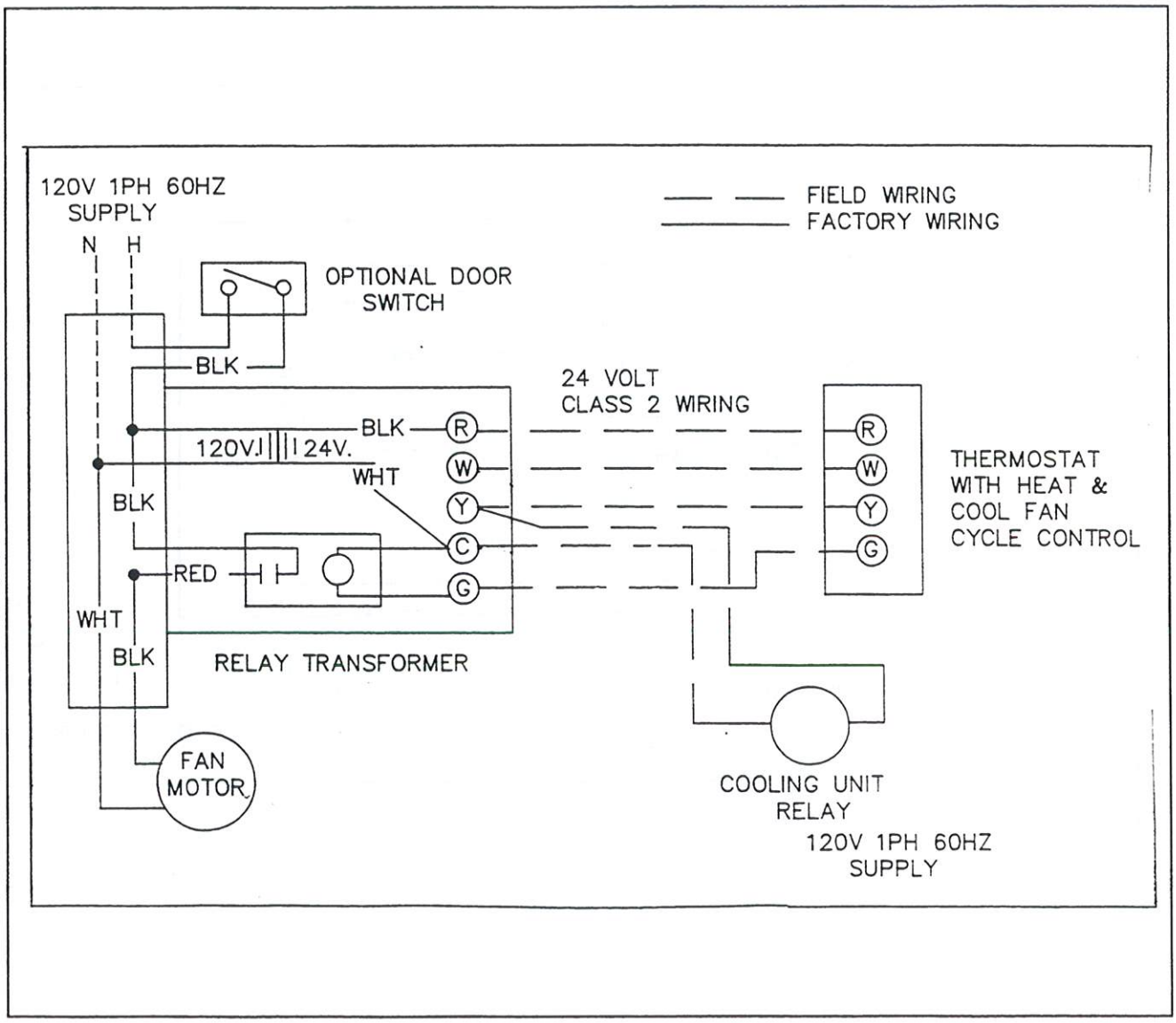
21.6. GB13010, GB16014 WITH HONEYWELL OR FENWAL HOT SURFACE IGNITION

SERVICE CODE 4

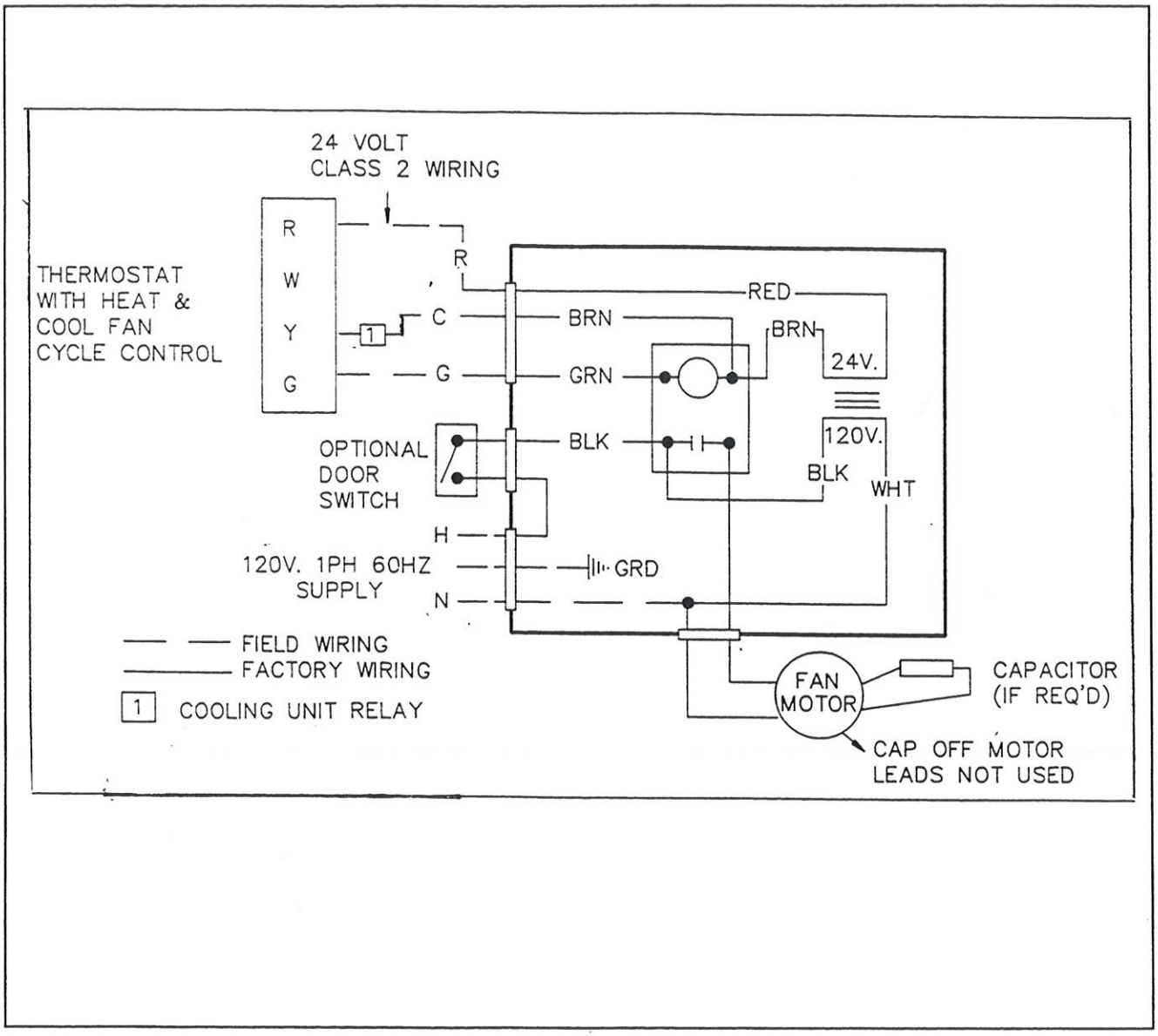

SCHEMATIC DIAGRAM
115 V 60HZ 1PH
PLUG-IN RELAY OPTS
CIRC PUMP RELAY
MOTOR
RUN CAP
LOOP CIRC PUMP
HOT SURFACE CONTROL
115 V
24 V
TRANSFORMER
HOT SURFACE CONTROL
FENWAL — HONEYWELL
(SEE NOTE #2)
NOTES:
1. IF ANY OF THE ORIGINAL WIRE AS SUPPLIED WITH THE APPLIANCE MUST BE REPLACED, IT MUST BE REPLACED WITH WIRING MATERIAL HAVING A TEMPERATURE RATING OF AT LEAST 105° C. OR IT'S EQUIVALENT.
2. FOR CONTINUOUS PUMP OPERATION, CONNECT PUMP RELAY TO "R" TERMINAL INSTEAD OF "W" ON LOW VOLTAGE TERMINAL BOARD
3 FOR FIELD INSTALLED CIRC PUMP AND RELAY COIL, CURRENT DRAW MUST NOT EXCEED .25 AMPS
WIRE CODE:
LOW VOLTAGE ——— FACTORY WIRING
HIGH VOLTAGE ——— FACTORY WIRING
LOW VOLTAGE - - - - - FIELD WIRING
HIGH VOLTAGE - - - - - FIELD WIRING
WIRE NUT ● FACTORY INSTALLED
WIRE NUT ○ FIELD INSTALLED
INSULATOR □ FACTORY INSTALLED
WIRE COLOR CODE:
B..... BLACK
W..... WHITE
R..... RED
Y..... YELLOW
BR..... BROWN
GAS BOILER WIRING DIAGRAM
GB 130/160 WITH HOT SURFACE IGNITION
FOR 24 VOLT SYSTEM ON NATURAL & PROPANE GASES
SERVICE CODE NO 4
COMBUSTION AIR PRESSURE SWITCH
PRESS SWITCH FLUE/GAS
GAS VALVE
HOT SURFACE CONTROL
FENWAL — HONEYWELL
HOT SURFACE IGNITER
HIGH LIMIT SWITCH
TEMPERATURE SWITCH
WATER PRESSURE SWITCH
TRANSFORMER SOCKET ASS'Y.
PLUG-IN RELAY
RUN CAPACITOR
COMB AIR MOTOR
LOOP CIRC PUMP
LOOP CIRC (IF USED) PUMP RELAY
(IF USED)
SEE NOTE NO 2 & 3
EXCESS TEMP SWITCH
HEAT ONLY THERMOSTAT SUB-BASE
2 WIRE THERMOSTAT CABLE
HOT LINE BLACK
NEUTRAL WHITE
115 V. 60 HZ 1 PH.

22. UNICORE AIR HANDLER WIRING DIAGRAMS

22.1. VDX WIRING DIAGRAM

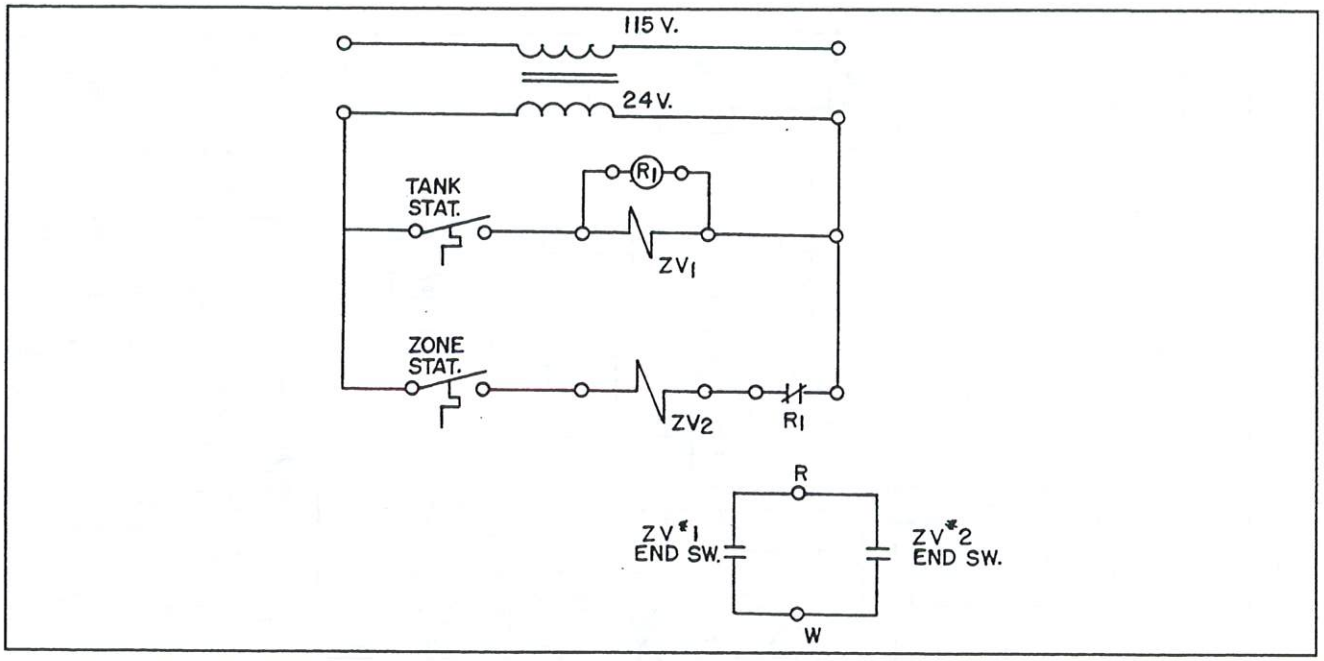


22.2. HWF WIRING DIAGRAM

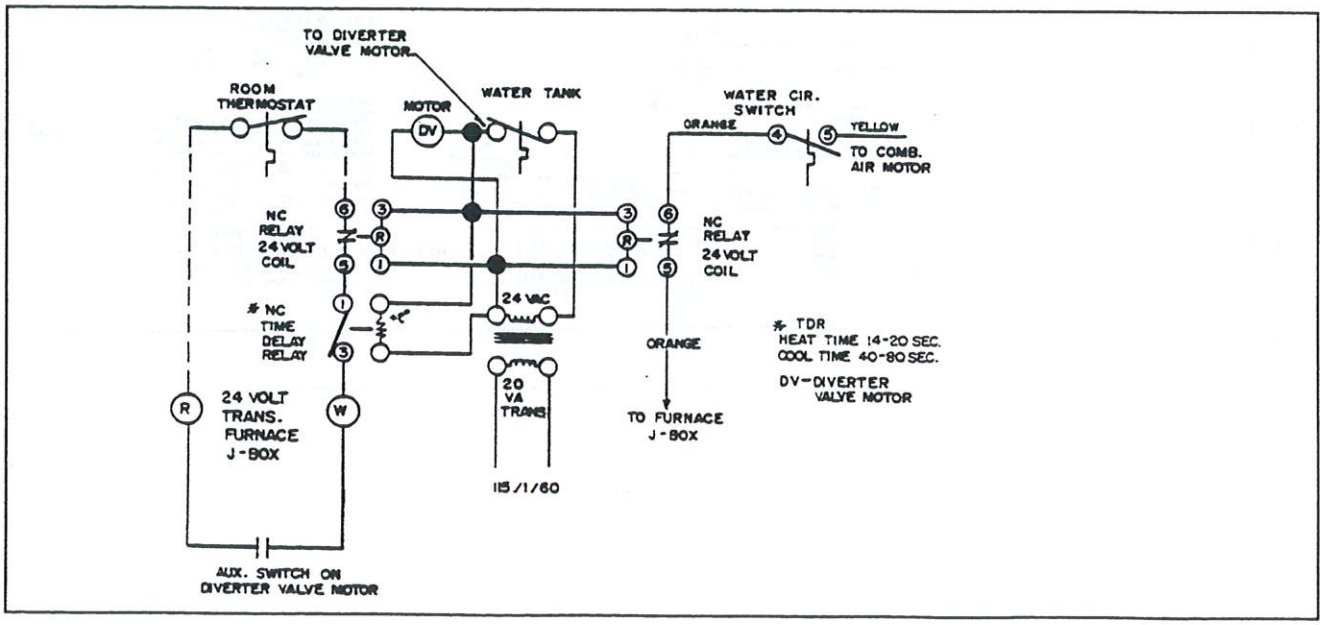


22.3. EXTERNAL CONTROL CIRCUITS

22.3.1. PRIORITY WATER HEATING WITH TWO-WAY ZONE VALVES

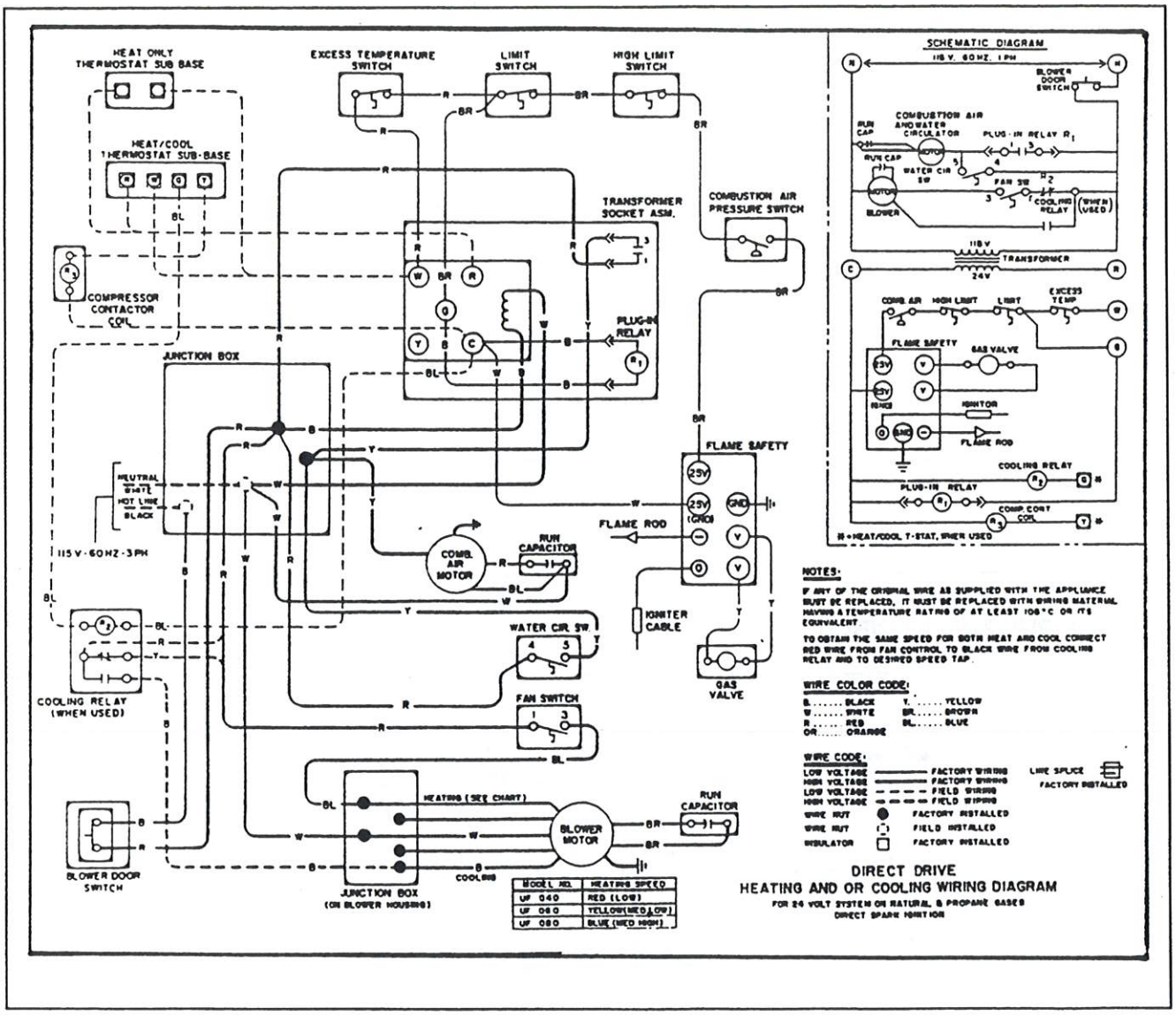


22.3.2. PUMP DELAY CIRCUIT

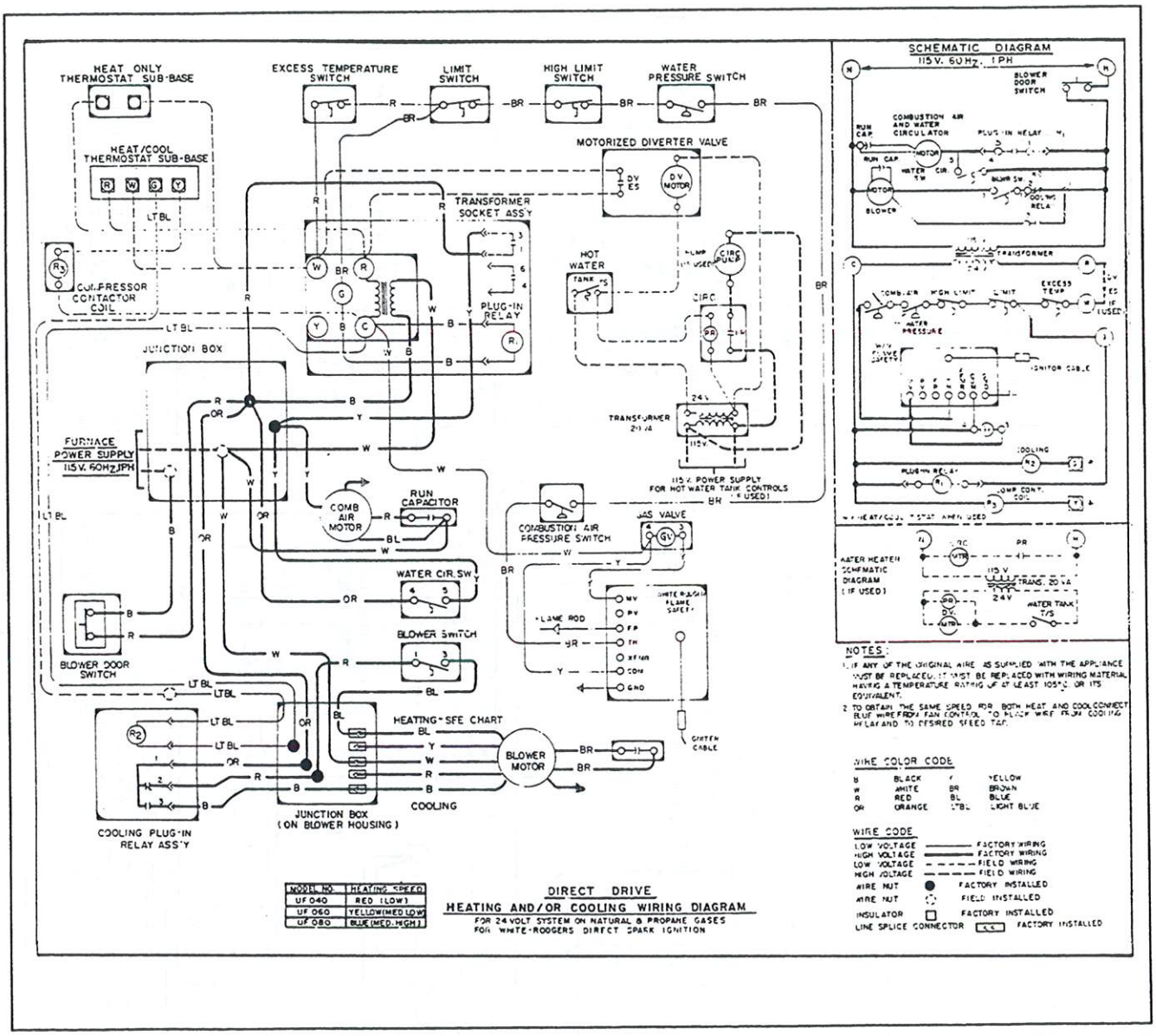


23. UF FURNACE WIRING DIAGRAMS

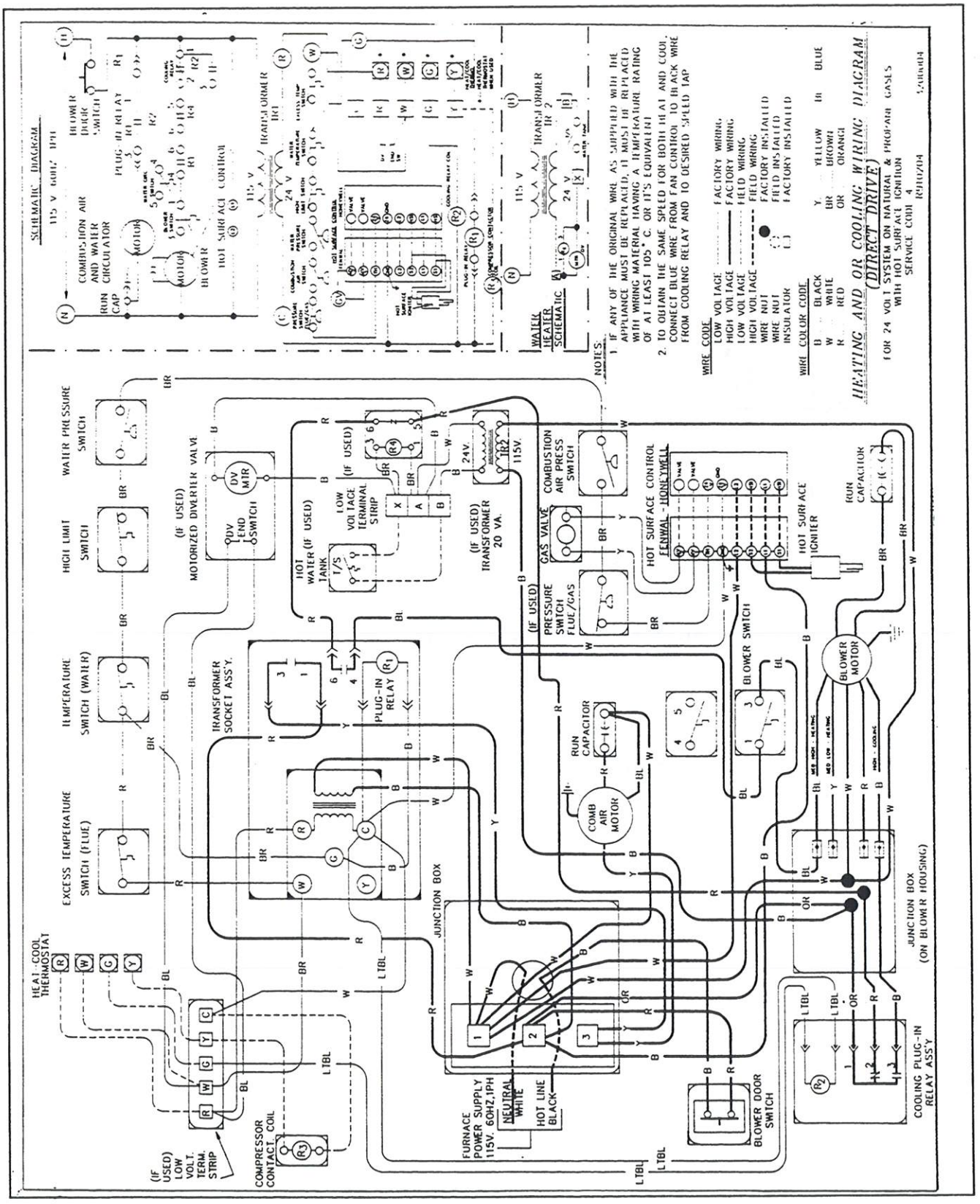
23.1. UF FURNACE--SERVICE CODE 1



23.2. UF FURNACE WITH HONEYWELL S87D SPARK IGNITION--SERVICE CODE 3



23.3. UF FURNACE WITH HONEYWELL OR FENWAL HOT SURFACE IGNITION -- SERVICE CODE 4


HEATING AND OR COOLING WIRING DIAGRAM
(DIRECT DRIVE)
FOR 24 VOLT SYSTEM ON NATURAL & PROPANE GASES
WITH HOT SURFACE IGNITION
SERVICE CODE 4
SCHEMATIC DIAGRAM
WATER HEATER SCHEMATIC
NOTES
1. IF ANY OF THE ORIGINAL WIRE AS SUPPLIED WITH THE APPLIANCE MUST BE REPLACED, IT MUST BE REPLACED WITH WIRING MATERIAL HAVING A TEMPERATURE RATING OF AT LEAST 105° C. OR ITS EQUIVALENT
2. TO OBTAIN THE SAME SPEED FOR BOTH HEAT AND COOL, CONNECT BLUE WIRE FROM FAN CONTROL TO BLACK WIRE FROM COOLING RELAY AND TO DESIRED SPEED TAP
WIRE CODE
LOW VOLTAGE ..... FACTORY WIRING
HIGH VOLTAGE ——— FACTORY WIRING
LOW VOLTAGE ——— FIELD WIRING
HIGH VOLTAGE - - - - - FIELD WIRING
WIRE NUT ● FACTORY INSTALLED
WIRE NUT ○ FIELD INSTALLED
INSULATOR ( ) FACTORY INSTALLED
WIRE COLOR CODE
B ... BLACK
W ... WHITE
R ... RED
Y ... YELLOW
BR ... BROWN
OR ... ORANGE
BL ... BLUE
HEAT-COOL THERMOSTAT
EXCESS TEMPERATURE SWITCH (FLUE)
TEMPERATURE SWITCH (WATER)
HIGH LIMIT SWITCH
WATER PRESSURE SWITCH
(IF USED) MOTORIZED DIVERTER VALVE
DV END SWITCH
DV MTR
HOT WATER (IF USED) TANK
(IF USED) LOW VOLTAGE TERMINAL STRIP
(IF USED) TRANSFORMER 20 VA.
TRANSFORMER SOCKET ASS'Y.
PLUG-IN RELAY
GAS VALVE
COMBUSTION AIR PRESS SWITCH
(IF USED) PRESSURE SWITCH FLUE/GAS
HOT SURFACE CONTROL FENWAL - HONEYWELL
HOT SURFACE IGNITER
RUN CAPACITOR
COMB AIR MOTOR
BLOWER SWITCH
BLOWER MOTOR
JUNCTION BOX
JUNCTION BOX (ON BLOWER HOUSING)
FURNACE POWER SUPPLY 115V. 60HZ, 1PH
NEUTRAL WHITE
HOT LINE BLACK
BLOWER DOOR SWITCH
COMPRESSOR CONTACT COIL
(IF USED) LOW VOLT. TERM. STRIP
COOLING PLUG-IN RELAY ASS'Y
LTBL

24. WT SERIES WATER HEATER

24.1. WT SERIES PERFORMANCE DATA WITH UF AND GB SERIES

WT SERIES FEATURES

- Tank — High Grade Stainless Steel
- Thermostat — Totally immersed, adjustable and replaceable
- Heat Exchanger — 15 sq. ft. Cupro-Nickel
- Insulation — 2" Rigid Polyurethane Environmentally Inert. Reduces heat loss to less than 2°F per hour

SPECIFICATIONS

Model No.	WT30SS	WT40SS	WT60SS
Domestic Tank Capacity	29 Gal.	40 Gal.	60 Gal.
Dimensions H x W (in.)	39 x 19¼	52½ x 19¼	52½ x 23¼
Ship. Wt. (lbs.)	55	70	109

NOTE: WT40SSC and WT60SSC models equipped with two coils.

GLOWCORE WATER HEATER PERFORMANCE

Determine amount of hot water needed; then use charts to select correct WTSS hot water heater. Use example 1 for residential use and example 2 for commercial applications.

FIRST HOUR DRAW AT 140°F. & 115°F. GALLONS PER ONE HOUR PERIOD*

RESIDENTIAL TANKS FURNACE / BOILER INPUT BTUH

Tank Model No.	40,000 BTUH		60,000 BTUH		80,000 BTUH		90,000 BTUH	
	140°F (90° Rise)	115°F (65° Rise)	140°F (90° Rise)	115°F (65° Rise)	140°F (90° Rise)	115°F (65° Rise)	140°F (90° Rise)	115°F (65° Rise)
WT30SS†	60 gals.	80 gals.	85 gals.	112 gals.	110 gals.	146 gals.	130 gals.	173 gals.
WT40SS†	70 gals.	93 gals.	100 gals.	132 gals.	120 gals.	159 gals.	141 gals.	188 gals.
WT60SS†	80 gals.	106 gals.	120 gals.	159 gals.	145 gals.	210 gals.	160 gals.	212 gals.

† Pressure drop with one (1) Heat Exchanger 12.5 feet of water (5.4 PSIG) @ 8 G.P.M.

*Rate of recovery (55° - 145°) plus usable storage based on department of energy tests.

COMMERCIAL TANKS BOILER INPUT BTUH

Tank Model No.	160,000 BTUH	
	140°F (90° Rise)	115°F (65° Rise)
**WT40SSC‡	165 gals.	219 gals.
**WT60SSC‡	185 gals.	246 gals.

‡Pressure drop with two (2) Heat Exchangers in parallel 12.5 feet of water (5.4 PSIG) @ 16 G.P.M. Total.

**Commercial tank with two (2) Heat Exchangers.

CONTINUOUS DUTY RATINGS — OUTLET WATER °F.

55°F. INLET WATER TEMPERATURE

RESIDENTIAL TANKS

Tank Model No.	Flow - G.P.M. 2	3	4	5	Input BTUH
WT30SS	110°	91°	82°	77°	60,000
WT40SS	121°	98°	91°	82°	80,000
WT60SS	132°	109°	97°	88°	90,000

COMMERCIAL TANKS

Tank Model No.	Flow - G.P.M. 3	4	5	6	Input BTUH
WT40SSC	149°	125°	111°	102°	160,000
WT60SSC	149°	125°	111°	102°	160,000

MINUTES OF WATER DRAW AT 140°F.

FOR PERFORMANCE AT 115°F. MULTIPLY BY 1.56

Tank Model No.	Flow - G.P.M. 2	3	4	5	Input BTUH
WT30SS	7.0	4.25	2.75	2.5	60,000
WT30SS	9.25	5.75	3.5	3.25	80,000
WT30SS	10.0	6.25	4.0	3.5	90,000
WT40SS	8.0	5.8	3.75	3.5	60,000
WT40SS	10.5	7.8	5.0	4.75	80,000
WT40SS	11.6	8.5	5.5	5.0	90,000
WT40SSC	10.6	7.8	4.9	4.6	80,000
WT40SSC	11.6	8.5	5.5	5.0	90,000
WT40SSC	21.0	15.1	10.0	9.0	160,000
WT60SS	12.1	8.9	5.6	5.2	80,000
WT60SS	13.2	9.7	6.3	5.7	90,000
WT60SSC	24.0	17.2	11.4	10.3	160,000

24.2. SIZING PROCEDURE FOR WATER HEATING -- ASHRAE METHOD

COMMERCIAL APPLICATIONS

For commercial applications the ASHRAE Systems Handbook using the fixture method should be used as a reference.

ASHRAE example shows the calculation for an apartment building. Note that if all of the fixtures were used at one time the "Possible Maximum Demand" is very high. You must multiply this figure by the demand factor shown in line 19 of table A. This product will give you the "Probable Maximum Demand" (PMD) in GPH of 140°F water.

EXAMPLE: Determination of heater and storage tank size for an apartment building from number of fixtures.

60 lavatories	x 2 = 120 gal per hr.
30 bathtubs	x20 = 600 gal per hr
30 showers	x30 = 900 gal per hr
60 kitchen sinks	x10 = 600 gal per hr
15 laundry tubs	x20 = 300 gal per hr
Possible Maximum Demand	= 2520 gal per hr

Probable Maximum Demand = 2520 x 0.30 = 756 gal/hr
Heater or coil capacity = 756 gal/hr
Storage tank capacity = 756 x 1.25 = 945 gal

Take the probable maximum demand and divide it by the continuous flow rate of water for a given size water heater. Say the PMD was 756 GPH. If we divide 756 by (.3 x 60) 180 GPH 149°F water which is the continuous flow rate for a WT40SSC or WT60SSC we get 4.2 tanks required. Try 756 divided by (.4 x 60) 240 GPH 125°F water which is the continuous flow rate for a WT40SSC or WT60SSC we get 3.1 tanks required.

WATER HEATER SIZING PROCEDURE — RESIDENTIAL USE

ESTIMATING YOUR PEAK HOUR DEMAND

1. Determine during what time of day (morning, noon, evening) there is the most use of hot water, keeping in mind the number of people.
2. Use the following table to determine your maximum usage of hot water in one hour. This is your peak demand.

Use	Average Gals. Hot Water Per Usage		Times Used Per Hour		Gallons Used One Hour
Shower	20	x		=	
Bath	20	x		=	
Shaving	2	x		=	
Hand & face washing	4	x		=	
Hair shampoo	4	x		=	
Hand dishwashing	4	x		=	
Auto dishwashing	14	x		=	
Food preparation	5	x		=	
Wringer clothes washer	26	x		=	
Auto clothes washer	32	x		=	

Example: Household uses most water in the morning. In the busiest one-hour period, the uses are:

3 Showers	20 x 3 = 60
1 Shave	2 x 1 = 2
1 Shampoo	4 x 1 = 4
Hand washing dishes	4 x 1 = 4
(peak hour demand)	70 gallons

In this case the peak hour demand is 70 gallons. Using Chart No. 1, select water heater with a first-hour rating of 70 gallons or larger. In most cases, 80,000 or 90,000 inputs will be required for space heating and water heater performance may be greater than sizing example.

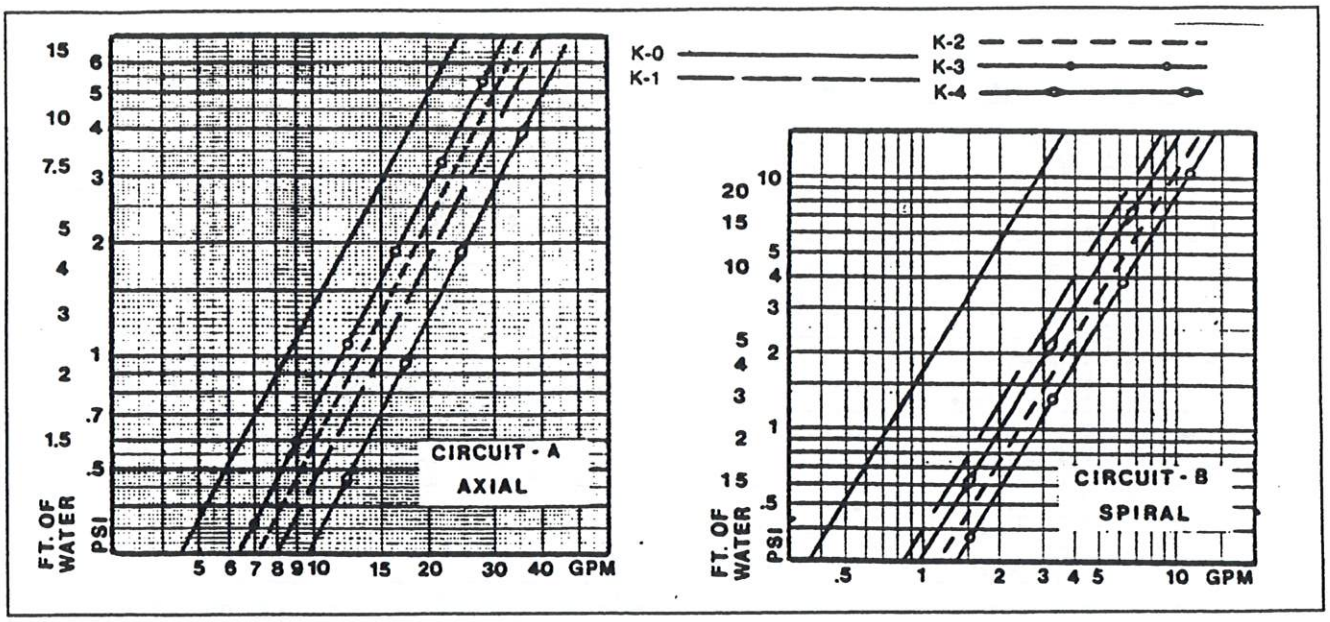
24.3 SIZING PROCEDURE FOR WATER HEATING -- ASHRAE METHOD

Table A ... Hot water demand per fixture for various types of buildings in gallons of water per hour per fixture, final temperature of 140°F.

		Apt. House	Club	Gym	Hosp.	Hotel	Ind. Plant	Off. Bldg.	Priv. Res.	School	YMCA
1	Basins, pr. av	2	2	2	2	2	2	2	2	2	2
2	Basins, public	4	6	8	6	8	12	6		15	8
3	Bathtubs	20	20	30	20	20			20		30
4	Dishwashers	15	50/150		50/150	50/200	20/100		15	20/100	20/100
5	Foot basin	3	3	12	3	3	12		3	3	2
6	Kitchen sink	10	20		20	30	20	20	10	20	20
7	Laundry tub	20	28		28	28			20		28
8	Pantry sink	5	10		10	10		10	5	10	10
9	Showers	30	150	225	75	75	225	30	30	225	225
10	Slop sink	20	20		20	30	20	20	15	20	20
11	Hydrotherapeutic showers				400						
12	Hubbard baths				600						
13	Leg baths				100						
14	Arm bath				35						
15	Sitz baths				30						
16	Continuous flow baths				165						
17	Circular wash sink				20	20	30	20		30	
18	Semicircular wash sinks				10	10	15	10		15	
19	Demand Factor	0.30	0.30	0.40	0.25	0.25	0.40	0.30	0.30	0.40	0.40
20	Storage capacity factor	1.25	0.90	1.00	0.60	0.80	1.00	2.00	0.70	1.00	1.00

25. SPIREC WATER-TO-WATER HEAT EXCHANGERS

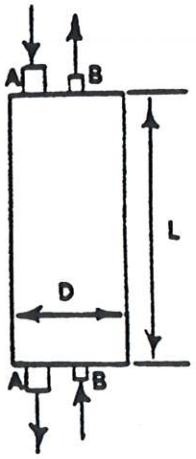
25.1. SPIREC FRICTION LOSS CURVES



25.2. SPIREC PHYSICAL DATA

PHYSICAL DATA

MODEL	HEAT TRANSFER SURFACE SQ. FT.	Diameter D Inches	Length L Inches	Connections Threaded A Inches	Connections Threaded B Inches	Weight Dry Lbs.	Weight Water Filled Lbs.
K-0	1.80	3-3/4"	6"	3/4"	1/2"	5.5	6.6
K-1	3.78	3-3/4"	10-3/4"	1"	1/2"	11	12.8
K-2	5.77	3-3/4"	15-1/2"	1"	3/4"	16.5	18.8
K-3	7.85	3-3/4"	20-1/4"	1"	3/4"	22	25.4
K-4	15.06	4-3/4"	20-1/4"	1-1/4"	3/4"	36	42



25.3. SPIREC INSTALLATION INFORMATION

Installation Information

SPIREC MODEL K

Heat Exchanger Orientation:

1. Liquid to Liquid Flows

   The heat exchanger should be mounted vertically. This assures total wetting of the heat transfer surface and allows for draining of the heat exchanger. ALTERNATE orientation: on an angle with the large outside connection (Circuit A) at the top, or horizontal with the large connection (Circuit A) at top. In either case the heat exchanger will not drain. Any other orientation is unacceptable. Air will be trapped and the heat transfer surface will not be totally wetted.

2. Vapor Condensing to Liquid Flows:

   The heat exchanger should always be mounted to assure complete condensate drainage. Vertical mounting is best with vapor in at top, condensate out at bottom. Pipe heated liquid counterflow. ALTERNATE is with heat exchanger on an angle with large outside connection (Circuit A) at bottom. In this case the condensate will not drain completely. Any other orientation is unacceptable.

3. Liquid Boiling to Liquid Flows:

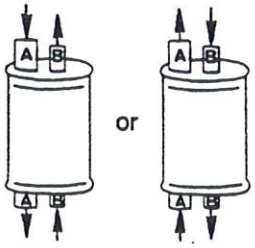
   Vertical mounting is best with evaporating liquid in at bottom and vapor out at top. All other orientations do not provide even distribution of evaporating liquid on heat transfer surface. Pipe cooled liquid counterflow. Any other orientation is unacceptable.

Piping:

1. All standard Model K heat exchangers are supplied with male pipe thread connections. Refer to Physical Data Table for connection size.

2. Pipe all heat exchangers counterflow as shown. This is the recommended piping arrangement with fluid streams flowing in opposite directions through the heat exchanger. The heat transfer requirements of certain applications may dictate other piping arrangements.

3. Always pipe high flow rate and/or high viscous fluid to the large connection circuit (Circuit A) and low flow rate low viscous fluid to the small connection circuit (Circuit B).



25.4. SPIREC SIZING INFORMATION

1. Given
   - Type of Application -
   - Temp. Rise Needed -
   - Desired Water Temp. -
   - Boiler Model -
   - Operation Temp. of Boiler -
2. Determine △T required to use tables below:
   - △T = T Boiler - T Water
   - T Boiler = Oper. Temp. Boiler
   - T Water = Desired Water Temp.
3. Enter table 2 or 3 depending on application - Select Spirec Model No. using △T from step 2 and boiler model
4. Refer to other tables and schematics for piping and pressure drops

NOTE: The following examples consider only the heat added to the water by the boiler size selected. The boiler sizes in the examples are not a recommendation for the specific application, since the application heat losses have not been determined. For example a 600 gal. hot tub in an outdoor installation might have heat losses greater than the capacity of the GB090. Then the selection of a GB090 will result in desired hot tub water temp. below 100°F.

APPLICATION:	
HOT TUB	POOL
600 gal.	20,000 gal.
TEMP RISE NEEDED:	
Initial heat-up	Initial heat-up
60°F to 100°F = 40°F rise	60°F to 80°F = 20°F rise
Maintain temp	Maintain temp
90°F to 100°F = 10°F rise	75°F to 80°F = 5°F rise
DESIRED WATER TEMP:	
100°F	80°F
BOILER SIZE: USE RECOVERY RATE TABLE 1, ENTER TEMP RISE COLUMN AND READ ACROSS TO SELECT BOILER SIZE WHICH GIVES ACCEPTABLE HEAT UP TIME.	
40°F rise GB090 240 gal/hr	20°F rise GB090 480 gal/hr
600 gal/240 gal/hr = 2.5 hrs	20,000 gal/480 gal/hr = 42 hrs
10°F rise GB090 959 gal/hr	5°F rise GB090 1918 gal/hr
600 gal/959 gal/hr = .63 hrs	20,000 gal/1918 gal/hr = 11 hrs
(.63 hrs x 60 min/hr = 38 min)	NOTE: (2) GB090 will cut times in half
OPERATING TEMP OF BOILER:	
170°F	170°F
DETERMINE △T FOR TABLES:	
△T = 170°F - 100°F	△T = 170°F - 80°F
△T = 70°F	△T = 90°F

ENTER TABLE 2 OR 3 TO SELECT SPIREC: USE TABLE WHICH BEST FITS APPLICATION THEN USE △T AND BOILER SIZE FOR SELECTION

TABLE 2	TABLE 2
70°F △T GB090	90°F △T GB090
SPIREC MODEL K-1 50°△T OR GREATER	SPIREC MODEL K-1 50°△T OR GREATER
NOTE: K-1 WILL PULL BOILER	NOTE: K-1 WILL PULL BOILER
OPERATING TEMP DOWN TO 150°F	OPERATING TEMP DOWN TO 130°F
BOILER TEMP = 50°F△T + 100°F	BOILER TEMP = 50°F△T + 80°F

FLOW, PRESSURE DROP, AND PIPING:
REFER TO TABLES OR DATA SHEETS FOR PRESSURE DROP AT FLOW RATE REQUIRED. SELECT PUMP TO MAINTAIN THE MINIMUM FLOW. MINIMUM FLOWS REDUCE SCALE AND MAINTAIN DESIGN HEAT TRANSFER AT DESIGN TEMPERATURE. PIPE SPIREC MODEL ACCORDING TO APPLICATION. SEE PIPING ARRANGEMENT FOR DETAILS.

26. PROPERTIES OF PIPE AND TUBING

26.1. EQUIVALENT LENGTH OF FITTINGS

The friction losses of various fittings are described in terms of the equivalent friction loss of the same size straight pipe.

Friction Losses Through Pipe Fittings and Valves

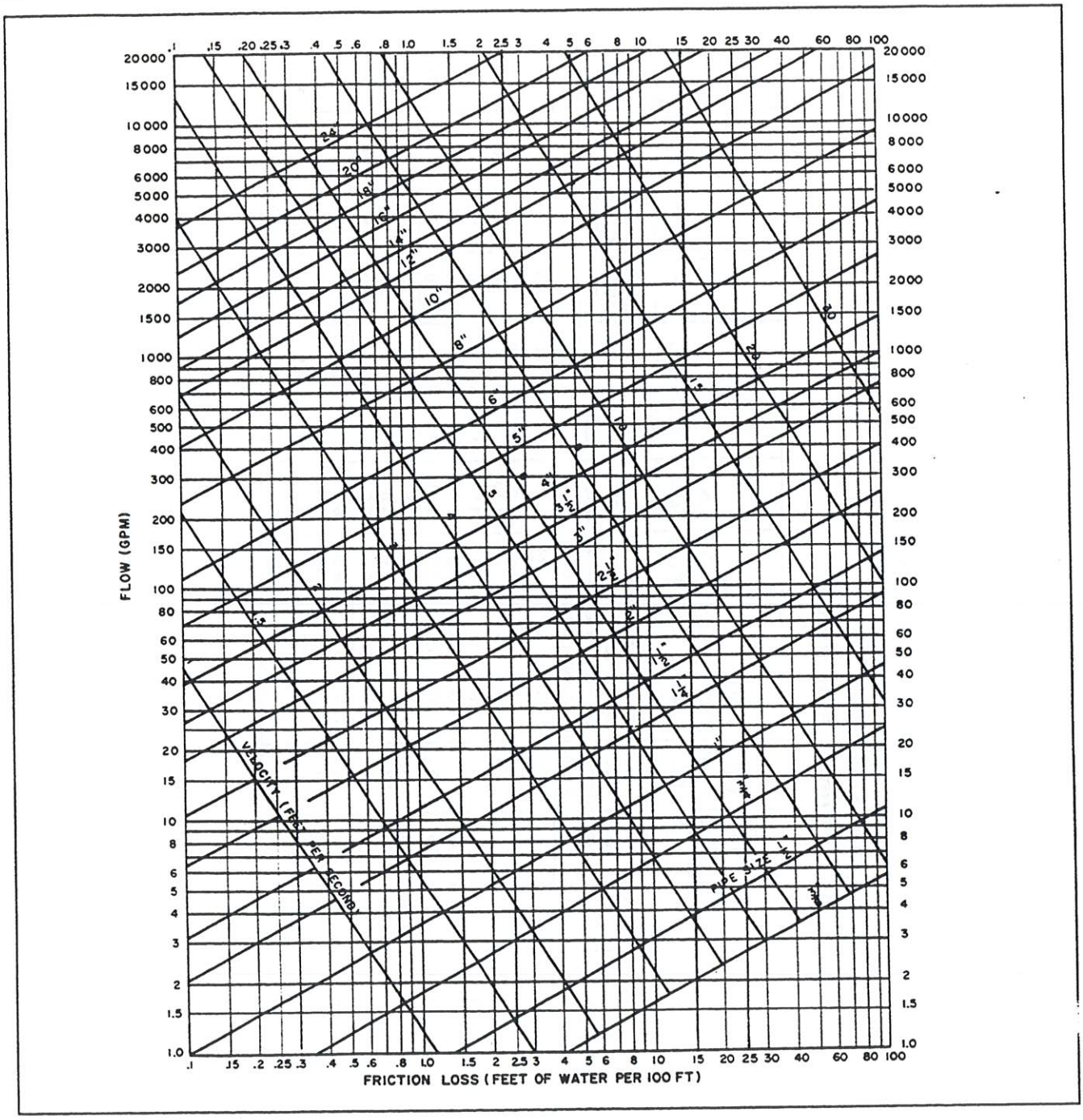
SIZE OF PIPE (Inches)	GATE VALVE				GLOBE VALVE – WIDE OPEN	ANGLE VALVE – WIDE OPEN	CHECK VALVE – WIDE OPEN	ORDINARY ENTRANCE TO PIPE LINES	STD. 90° ELBOW	MEDIUM SWEEP 90° ELBOW	LONG SWEEP 90° ELBOW	45° ELBOW	SQUARE 90° ELBOW	CLOSE RETURN BENDS	STD. TEE	STD. TEE
	WIDE OPEN	¼ CLOSED	½ CLOSED	¾ CLOSED												
	STRAIGHT PIPE IN FEET (EQUIVALENT LENGTH)															
⅛"	.14	.85	5.0	19	9	5	2.0	.46	.74	.65	.50	.40	1.6	2.0	.50	1.6
¼"	.21	1.25	7.0	26	12	6	3.0	.60	1.0	.86	.70	.50	2.3	3.0	.70	2.3
⅜"	.27	1.80	9.0	36	16	8	4.0	.75	1.4	1.15	.90	.65	3.0	4.0	.90	3.0
½"	.33	2.10	12.0	44	18	9	5.0	.90	1.6	1.50	1.10	.80	4.0	5.0	1.10	4.0
¾"	.46	2.9	14.0	59	23	12	6.0	1.4	2.3	2.0	1.5	1.0	5.0	6.0	1.5	5.0
1"	.61	3.4	18.0	70	29	15	7.0	1.6	2.7	2.5	2.0	1.5	6.0	7.0	2.0	6.0
1¼"	.79	4.8	24.0	96	38	20	9.0	2.5	3.6	3.5	2.5	1.7	8.0	9.0	2.5	8.0
1½"	.93	5.6	28.0	116	46	23	11.0	3.0	4.5	4.0	2.9	2.0	9.5	11.0	2.9	9.5
2"	1.21	7.0	36.0	146	58	29	15.0	3.5	5.4	5.0	3.6	2.5	13.0	14.0	3.6	13.0
2½"	1.39	8.4	41.0	172	69	35	17.0	4.0	6.5	6.0	4.4	3.0	15.0	16.0	4.4	15.0
3"	1.69	10.0	52.0	213	86	43	21.0	5.0	8.5	7.0	5.5	4.0	18.0	19.0	5.5	18.0
3½"	2.10	12.5	60.0	246	100	52	24.0	5.5	10.0	8.5	6.3	4.5	20.0	22.0	6.3	20.0
4"	2.40	14.0	70.0	285	116	57	27.0	6.5	12.0	9.5	7.2	5.0	23.0	25.0	7.2	23.0

NOTE: ⅛" to 4" are standard pipe sizes.

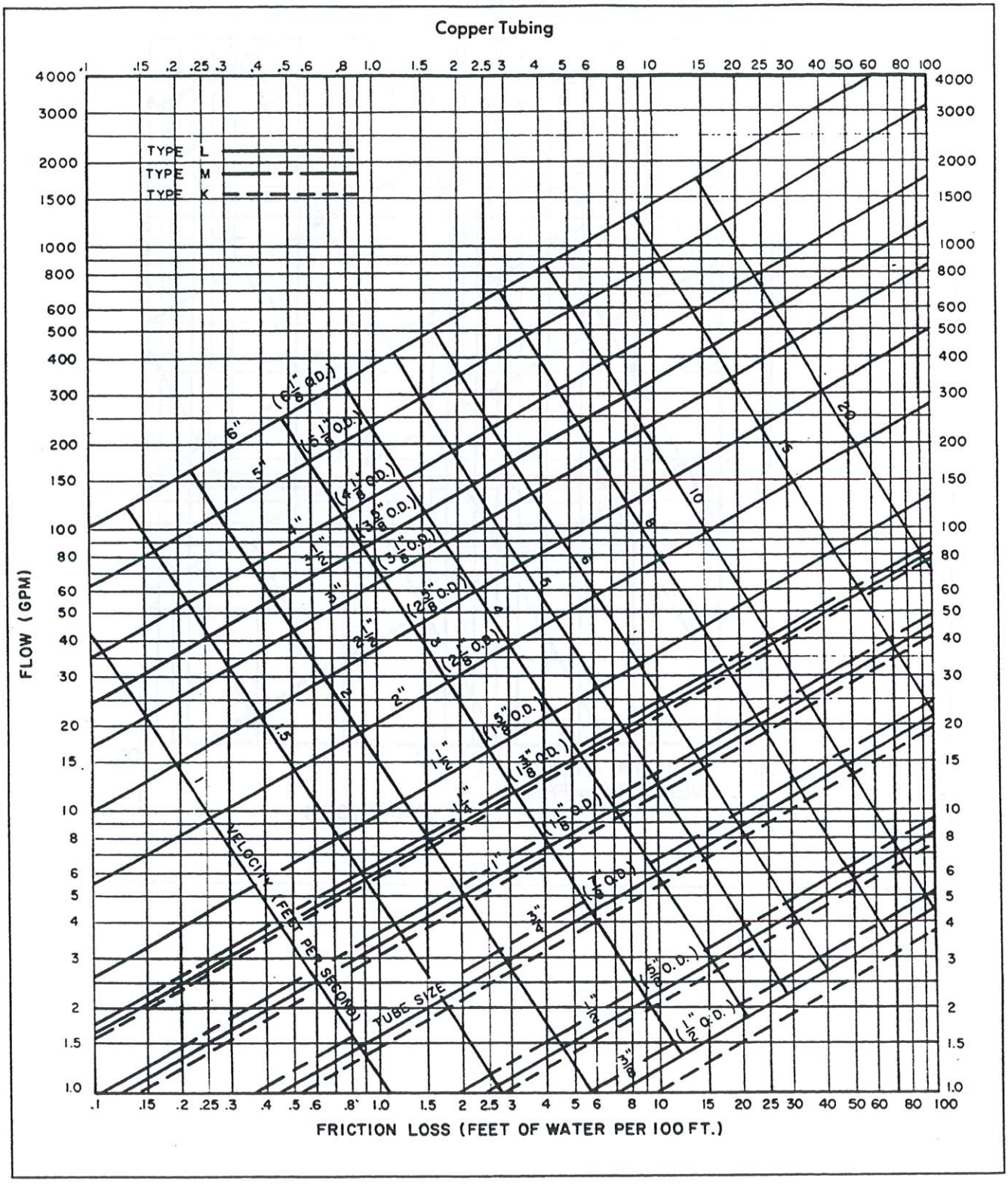
26.2. PIPE FRICTION LOSS

After converting fittings to equivalent length of pipe, add the result to the total amount of straight pipe and refer to the appropriate chart to determine the amount of head contributed by the piping at the necessary rate of flow.

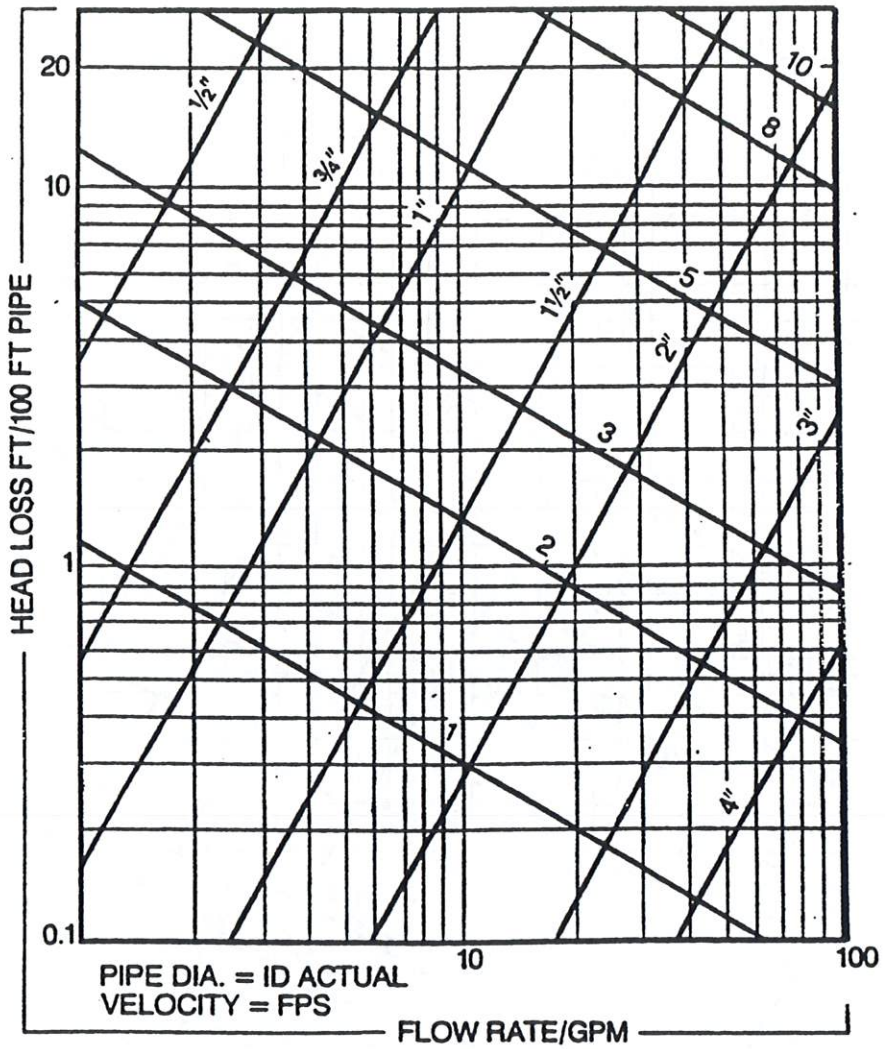
26.2.1. FRICTION LOSS FOR SCHEDULE 40 IRON PIPE



26.2.2. FRICTION LOSS FOR COPPER TUBING



26.2.3. FRICTION LOSS FOR PLASTIC TUBING



26.3. PHYSICAL PROPERTIES OF PIPE AND TUBING

Physical properties and dimensions of iron pipe sizes and tubing sizes are listed here for reference.

26.3.1. THERMAL LINEAR EXPANSION OF IRON PIPE AND COPPER TUBING

(Inches Per 100 Ft.)

TEMP. RANGE (F)	COPPER TUBING	STEEL PIPE
0	0	0
50	.56	.37
100	1.12	.76
150	1.69	1.15
200	2.27	1.55
250	2.85	1.96
300	3.45	2.38
350	4.05	2.81
400	4.65	3.25
450	5.27	3.70
500	5.89	4.15

NOTE: Above data is based on expansion from 0° F but is sufficiently accurate for all other temperature ranges.

FIG. 26.3.1. *Pipe and tubing expands as it is heated and allowances should be made for expansion according to the above table.*

26.3.2. PHYSICAL PROPERTIES OF COPPER TUBING

CLASSIFICATION	NOM. TUBE SIZE (in.)	OUTSIDE DIA (in.)	STUBBS GAGE	WALL THICKNESS (in.)	INSIDE DIAM (in.)	TRANSVERSE AREA (sq in.)	MINIMUM TEST PRESSURE (psi)	WEIGHT OF TUBE (lb/ft)	WT OF WATER IN TUBE* (lb/ft)	OUTSIDE SURFACE (sq ft/ft)
HARD	1/4	3/8	23	025	325	083	1000	106	036	098
	3/8	1/2	23	025	490	159	1000	144	069	131
	1/2	5/8	22	028	569	254	890	203	110	164
	3/4	7/8	21	032	811	516	710	328	224	229
	1	1-1/2	20	035	1 055	874	600	464	379	295
	1-1/4	1-3/8	19	042	1 291	1 309	590	681	568	360
Govt. Type "M" 250 Lb Working Pressure	1-1/2	1-5/8	18	049	1 527	1 831	580	94	793	425
	2	2-1/8	17	058	2.009	3.17	520	1 56	1 372	556
	2-1/2	2-5/8	16	065	2.495	4 89	470	2 03	2 120	687
	3	3-1/8	15	072	2.981	698	440	2 68	3 020	818
	3-1/2	3-5/8	14	083	3.459	9.40	430	3 58	4 060	949
	4	4-1/8	13	095	3.935	12.16	430	4 66	5 262	1 08
	5	5-1/8	12	109	4.907	18 91	400	6 66	8.180	1 34
	6	6-1/8		1 22	5.881	27 16	375	8.91	11 790	1 60
	8	8-1/8		170	7.785	47 6	375	18.48	20 60	2 13
HARD	3/8	1/2	19	035	4 30	146	1000	198	063	131
	1/2	5/8		040	.946	233	1000	284	101	164
	3/4	7/8		045	785	484	1000	454	209	229
	1	1-1/8		050	1.025	.825	880	653	358	295
	1-1/4	1-3/8		055	1.265	1.255	780	882	554	360
Govt. Type "L" 298 Lb Working Pressure	1-1/2	1-5/8		060	1.505	1.78	720	114	770	425
	2	2-1/8		070	1.985	3.094	640	1.75	1 338	556
	2-1/2	2-5/8		080	2.465	4.77	580	2.48	2.070	687
	3	3-1/8		090	2.945	6.812	580	3.33	2.975	818
	3-1/2	3-5/8		100	3.425	9.213	530	4 29	4.000	949
	4	4-1/8		110	3.905	11.97	510	5.38	5 180	1 08
	5	5-1/8		125	4.875	18.67	480	7 61	8.090	1 34
	6	6-1/8		140	5.845	28.83	430	10 20	11 610	1 60
HARD	1/4	3/8	21	032	311	.076	1000	133	033	098
	3/8	1/2	18	045	402	127	1000	289	055	131
	1/2	5/8	18	045	527	218	1000	344	094	164
	3/4	7/8	18	065	745	436	1000	641	189	229
	1	1-1/8	18	065	.995	.778	780	838	336	295
	1-1/4	1-3/8	18	065	1.245	1.217	630	1 04	526	360
Govt. Type "K" 400 Lb Working Pressure	1-1/2	1-5/8	19	072	1.481	1.722	580	1 36	745	425
	2	2-1/8	16	083	1.959	3.014	510	2.06	1.300	556
	2-1/2	2-5/8	13	095	2.435	4 656	470	2.92	2.015	687
	3	3-1/8	12	109	2.907	6.637	450	4 00	2.870	818
	3-1/2	3-5/8	11	120	33.388	8.999	430	5 12	3.890	949
	4	4-1/2	10	134	3.887	11.86	420	6 51	5 05	1 08
	5	5-1/8		160	4.805	1813	400	9 67	7 80	1 34
	6	6-1/2		192	5.741	25.88	400	13.87	11 20	1 60

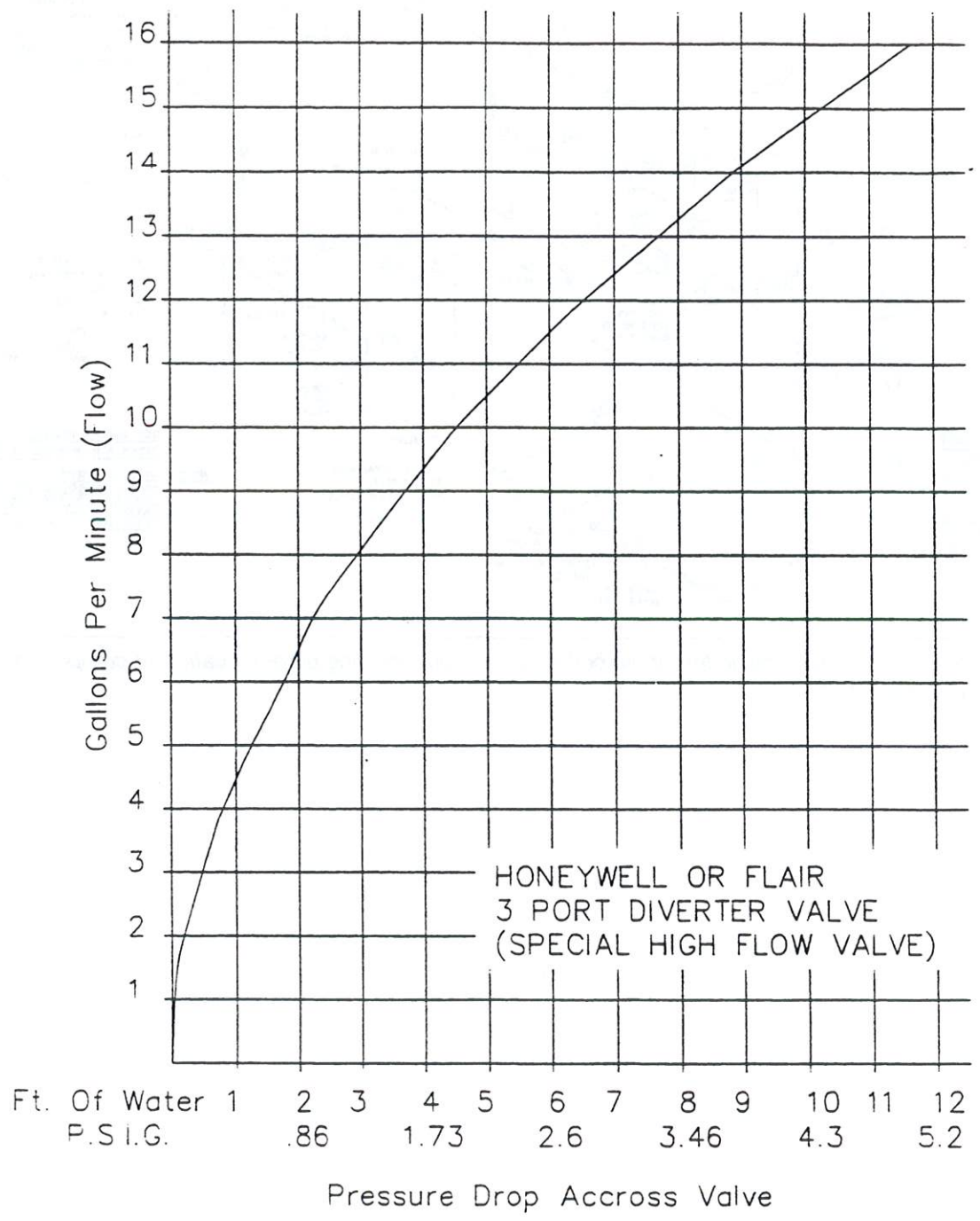
FIG. 26.3.2 *Physical properties of type "K," "L," and "M" hard copper tubing.*

26.3.3. PHYSICAL PROPERTIES OF SCHEDULE 40 IRON PIPE

NOM. PIPE SIZE (in.)	SCHEDULE NO.†	OUTSIDE DIAM (in.)	INSIDE DIAM (in.)	WALL THICK-NESS (in.)	WEIGHT OF PIPE (lb/ft)	WT OF WATER IN PIPE* (lb/ft)	OUTSIDE SURFACE (sq ft/ft)	INSIDE SURFACE (sq ft/ft)	TRANS-VERSE AREA (sq in.)
⅛	40(S)	.405	.269	.068	.244	.0246	.106	.0705	.0568
	80(X)	.405	.215	.095	.314	.0157	.106	.0563	.0364
¼	40(S)	.540	.364	.088	.424	.0451	.141	.0955	.1041
	80(X)	.540	.302	.119	.535	.0310	.141	.0794	.0716
⅜	40(S)	.675	.493	.091	.567	.0827	.177	.1295	.1910
	80(X)	.675	.423	.126	.738	.0609	.177	.1106	.1405
½	40(S)	.840	.622	.109	.850	.1316	.220	.1637	.3040
	80(X)	.840	.546	.147	1.087	.1013	.220	.1433	.2340
¾	40(S)	1.050	.824	.113	1.130	.2301	.275	.2168	.5330
	80(X)	1.050	.742	.154	1.473	.1875	.275	.1948	.4330
1	40(S)	1.315	1.049	.133	1.678	.3740	.344	.2740	.8640
	80(X)	1.315	.957	.179	2.171	.3112	.344	.2520	.7190
1¼	40(S)	1.660	1.380	.140	2.272	.6471	.434	.3620	1.495
	80(X)	1.660	1.278	.191	2.996	.5553	.434	.3356	1.283
1½	40(S)	1.900	1.610	.145	2.717	.8820	.497	.4213	2.036
	80(X)	1.900	1.500	.200	3.631	.7648	.497	.3927	1.767
2	40(S)	2.375	2.067	.154	3.652	1.452	.622	.5401	3.355
	80(X)	2.375	1.939	.218	5.022	1.279	.622	.5074	2.953
2½	40(S)	2.875	2.469	.203	5.79	2.072	.753	.6462	4.788
	80(X)	2.875	2.323	.276	7.66	1.834	.753	.6095	4.238
3	40(S)	3.500	3.068	.216	7.57	3.20	.916	.802	7.393
	80(X)	3.500	2.900	.300	10.25	2.86	.916	.761	6.605
3½	40(S)	4.000	3.548	.226	9.11	4.28	1.047	.929	9.89
	80(X)	4.000	3.364	.318	12.51	3.85	1.047	.880	8.89
4	40(S)	4.500	4.026	.237	10.79	5.51	1.178	1.055	12.73
	80(X)	4.500	3.826	.337	14.98	4.98	1.178	1.002	11.50
5	40(S)	5.563	5.047	.258	14.62	8.66	1.456	1.321	20.01
	80(X)	5.563	4.813	.375	20.78	7.87	1.456	1.260	18.19
6	40(S)	6.625	6.065	.280	18.97	12.51	1.735	1.587	28.99
	80(X)	6.625	5.761	.432	28.57	11.29	1.735	1.510	26.07
8	40(S)	8.625	7.981	.322	28.55	21.6	2.26	2.090	50.0
	80(X)	8.625	7.625	.500	43.39	19.8	2.26	2.006	45.6

FIG. 26.3.3 *Physical properties and dimensions of schedule 40 iron pipe (ips).*

26.4. DIVERTER VALVE FRICTION LOSS



27. PIPING SCHEMATICS

27.1. TYPICAL BOILER/WATER HEATER SCHEMATIC

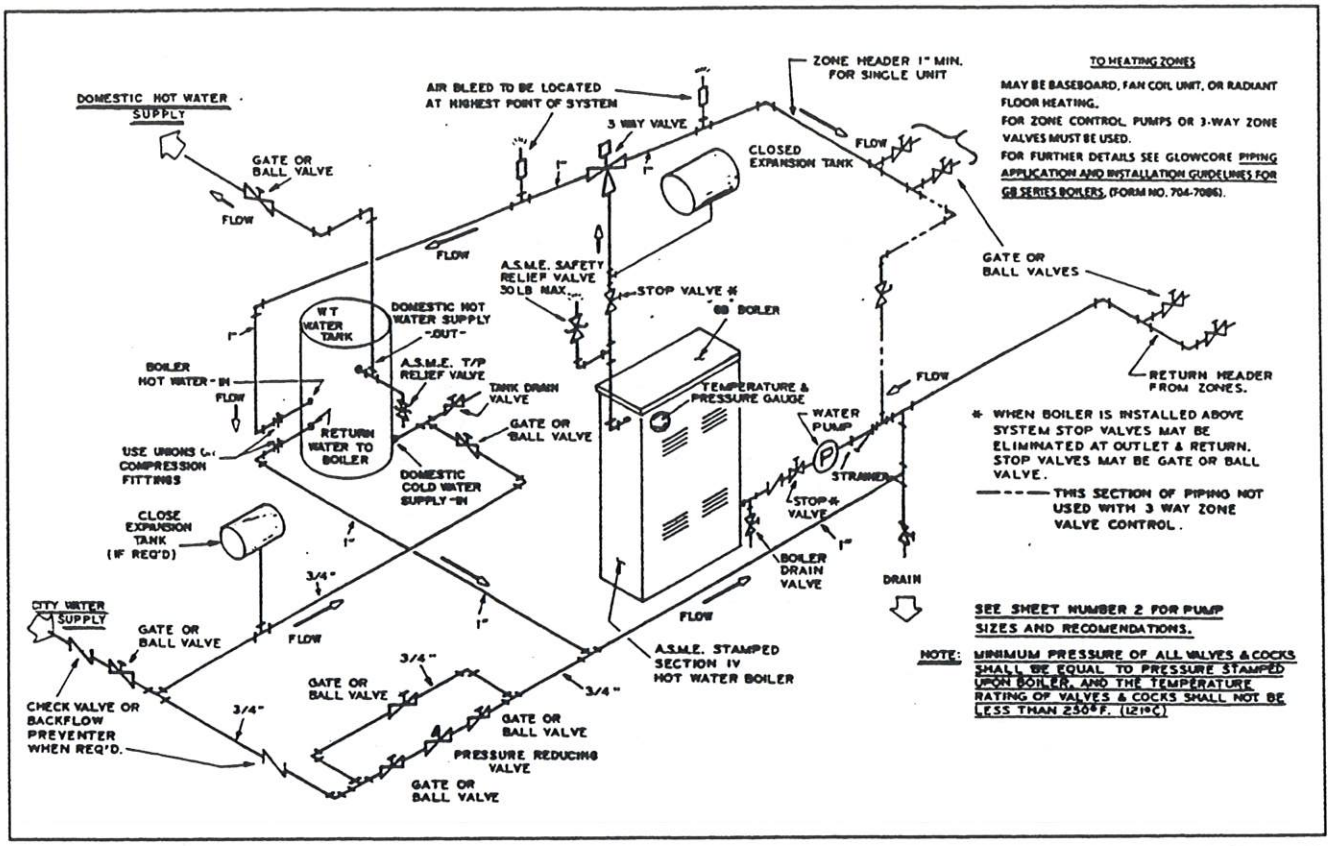

DOMESTIC HOT WATER SUPPLY
GATE OR BALL VALVE
FLOW
AIR BLEED TO BE LOCATED AT HIGHEST POINT OF SYSTEM
3 WAY VALVE
ZONE HEADER 1" MIN. FOR SINGLE UNIT
CLOSED EXPANSION TANK
TO HEATING ZONES
MAY BE BASEBOARD, FAN COIL UNIT, OR RADIANT FLOOR HEATING.
FOR ZONE CONTROL, PUMPS OR 3-WAY ZONE VALVES MUST BE USED.
FOR FURTHER DETAILS SEE GLOWCORE PIPING APPLICATION AND INSTALLATION GUIDELINES FOR GB SERIES BOILERS, (FORM NO. 704-7086).
A.S.M.E. SAFETY RELIEF VALVE 30LB MAX.
STOP VALVE *
GB BOILER
GATE OR BALL VALVES
WT WATER TANK
DOMESTIC HOT WATER SUPPLY -OUT-
BOILER HOT WATER - IN
A.S.M.E. T/P RELIEF VALVE
TANK DRAIN VALVE
GATE OR BALL VALVE
TEMPERATURE & PRESSURE GAUGE
WATER PUMP
RETURN HEADER FROM ZONES.
RETURN WATER TO BOILER
DOMESTIC COLD WATER SUPPLY -IN
USE UNIONS OR COMPRESSION FITTINGS
STRAINER
STOP * VALVE
CLOSE EXPANSION TANK (IF REQ'D)
BOILER DRAIN VALVE
DRAIN
* WHEN BOILER IS INSTALLED ABOVE SYSTEM STOP VALVES MAY BE ELIMINATED AT OUTLET & RETURN. STOP VALVES MAY BE GATE OR BALL VALVE.
THIS SECTION OF PIPING NOT USED WITH 3 WAY ZONE VALVE CONTROL.
CITY WATER SUPPLY
GATE OR BALL VALVE
CHECK VALVE OR BACKFLOW PREVENTER WHEN REQ'D.
A.S.M.E. STAMPED SECTION IV HOT WATER BOILER
PRESSURE REDUCING VALVE
SEE SHEET NUMBER 2 FOR PUMP SIZES AND RECOMENDATIONS.
NOTE: MINIMUM PRESSURE OF ALL VALVES & COCKS SHALL BE EQUAL TO PRESSURE STAMPED UPON BOILER, AND THE TEMPERATURE RATING OF VALVES & COCKS SHALL NOT BE LESS THAN 250°F. (121°C)

FIG. 27.1 *Typical schematic for single boiler application including proper location of components and domestic water heating option.*

27.2. TYPICAL BOILER SCHEMATIC FOR SMALL ZONES

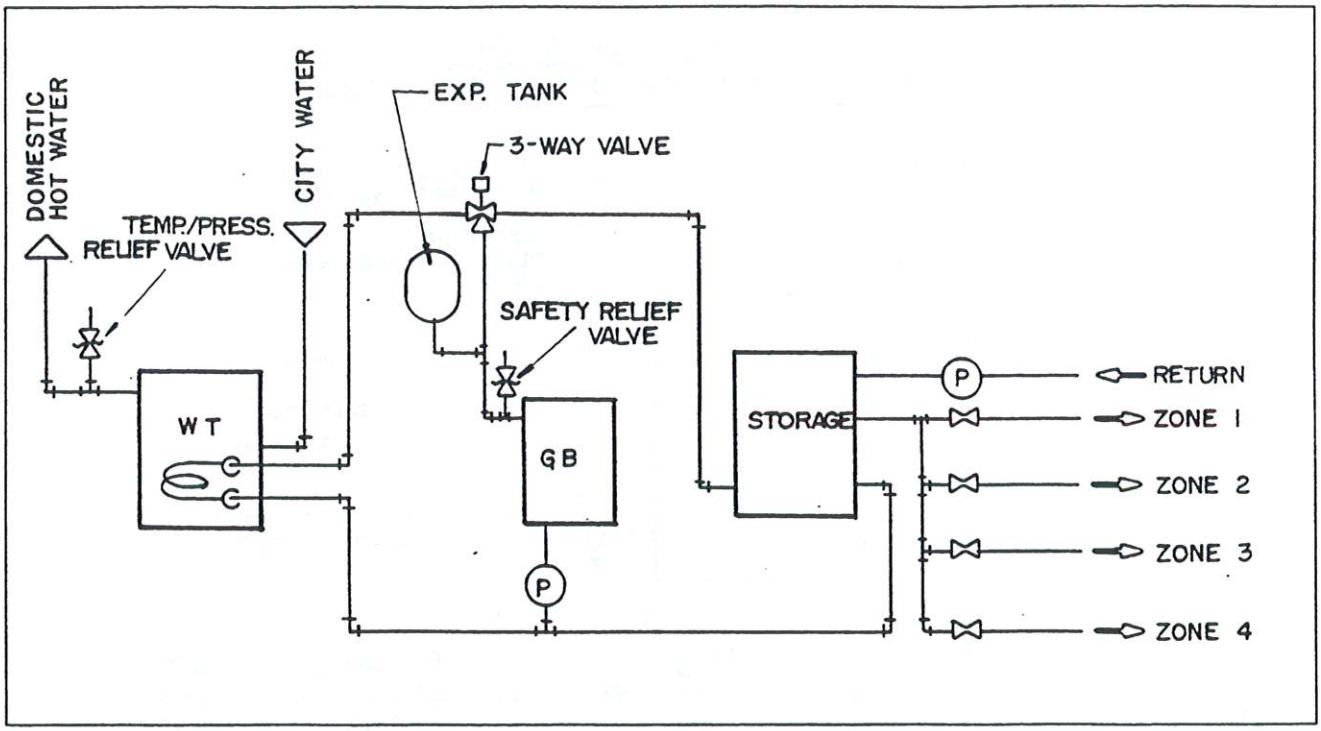


FIG. 27.2. *Use a buffer tank as shown to allow for adequate loading of boiler when system includes numerous small zones.*

27.3. MULTIPLE PUMP-CONTROLLED ZONES

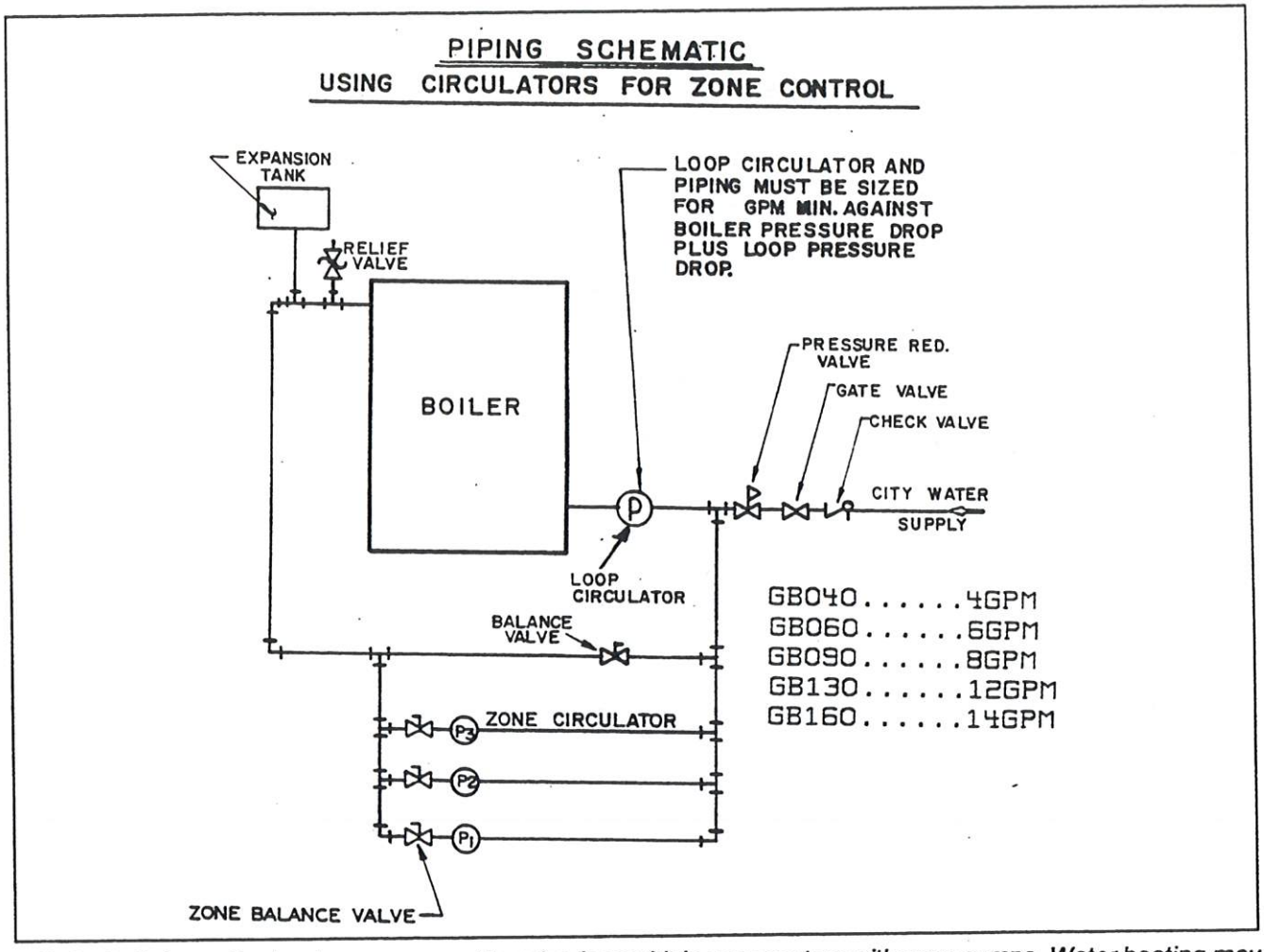


FIG. 27.3. *Schematic showing component location for multiple zone system with zone pumps. Water heating may be added by locating a three-way diverter after the expansion tank.*

27.4. MULTIPLE ZONE SYSTEM CONTROLLED WITH THREE-WAY VALVES

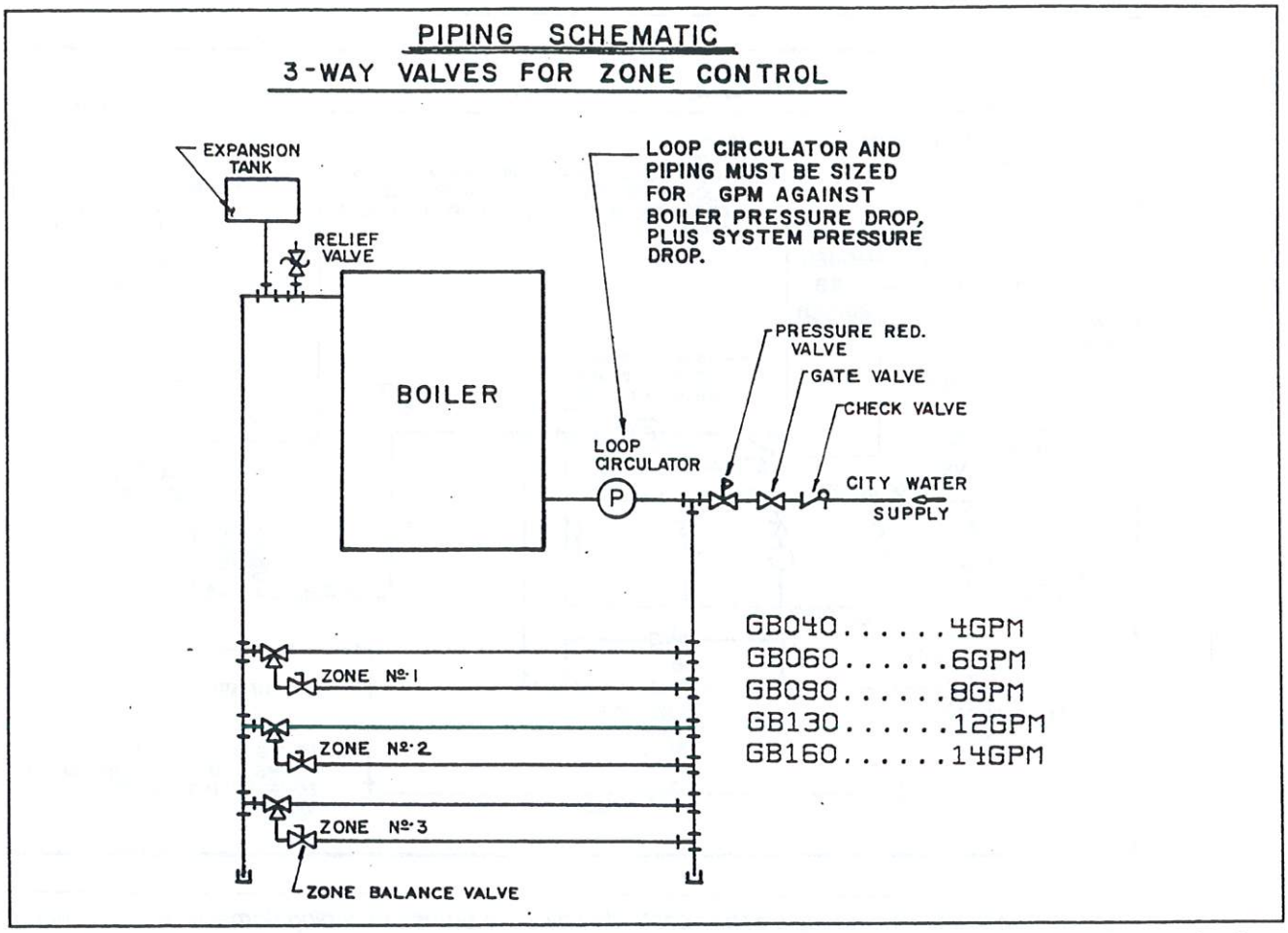


FIG. 27.4. *Schematic shows piping configuration for multiple zone system using three-way zone control valves. Flow through boiler is assured when not all zones are calling through the zone bypass.*

27.5. MULTIPLE PUMP CONTROLLED ZONES WITH WATER HEATING

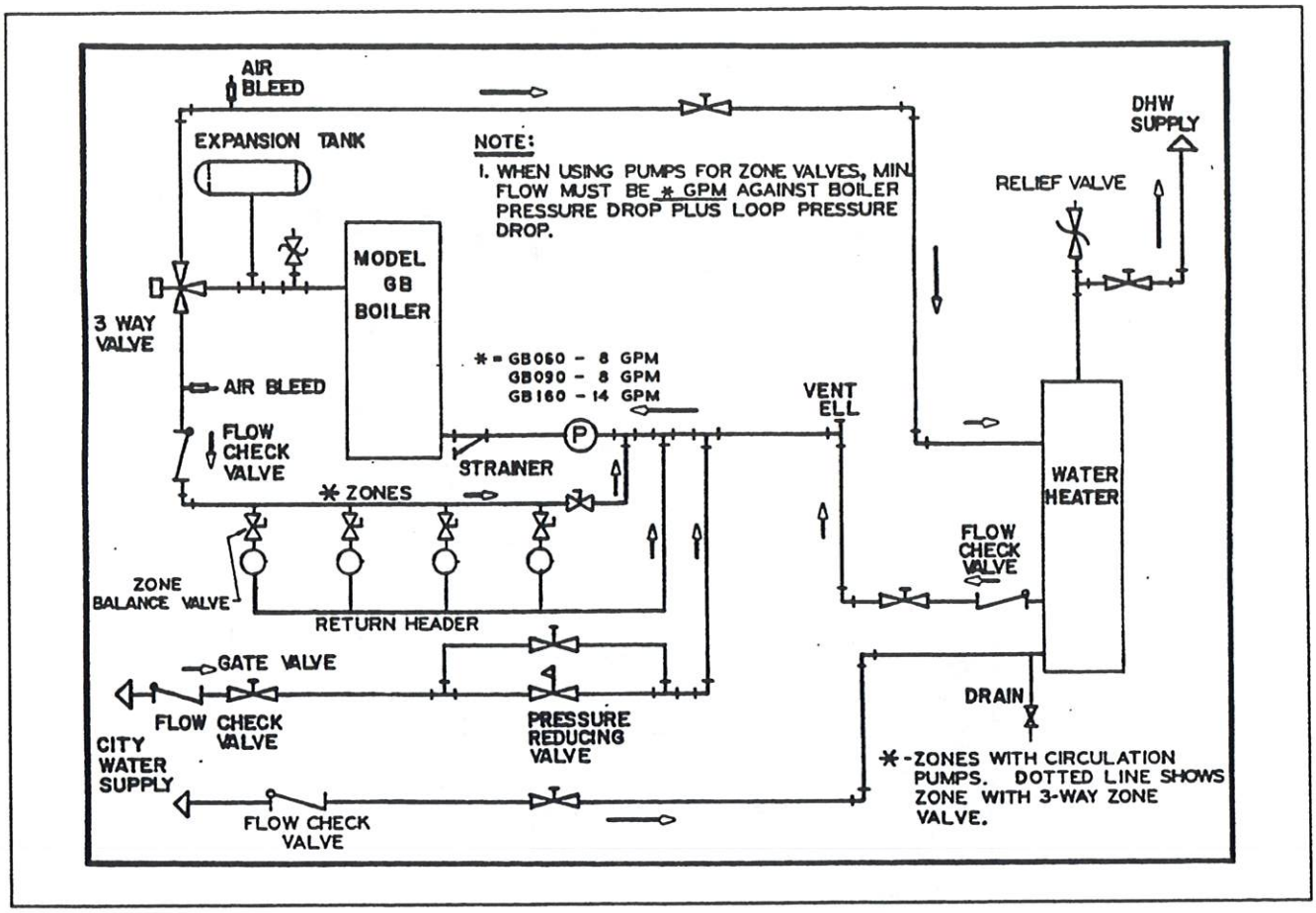


FIG. 27.5 *Schematic showing multiple zones controlled by zone pumps including domestic water heating option. Boiler pump must be sized to overcome boiler, water tank, and piping flow restrictions.*

27.6. MULTIPLE THREE-WAY VALVE CONTROLLED ZONES WITH WATER HEATING

TYPICAL PIPING SCHEMATIC FOR BOILER & DHW TANK FOR GB040, 060, 090, 130, 160.

GB040 ..... 4GPM
GB060 ..... 6GPM
GB090 ..... 8GPM
GB130 ..... 12GPM
GB160 ..... 14GPM

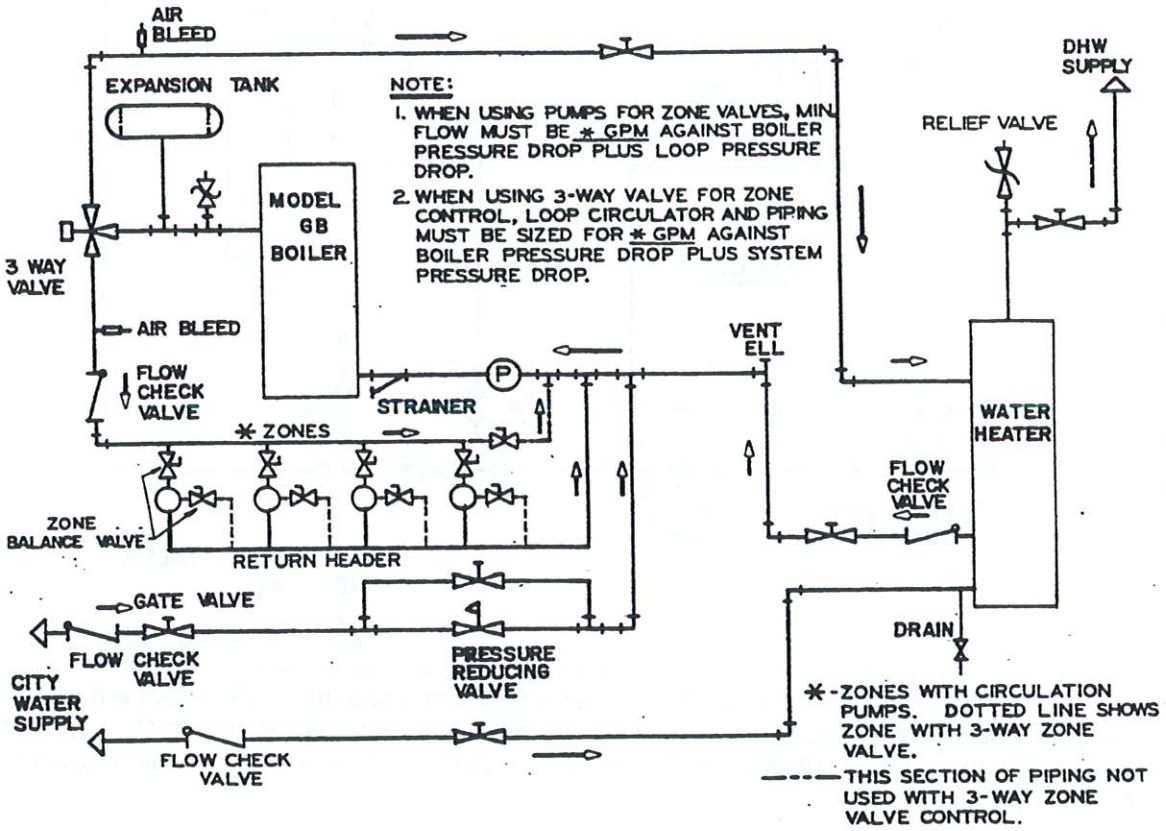

AIR BLEED
EXPANSION TANK
NOTE:
1. WHEN USING PUMPS FOR ZONE VALVES, MIN. FLOW MUST BE * GPM AGAINST BOILER PRESSURE DROP PLUS LOOP PRESSURE DROP.
2. WHEN USING 3-WAY VALVE FOR ZONE CONTROL, LOOP CIRCULATOR AND PIPING MUST BE SIZED FOR * GPM AGAINST BOILER PRESSURE DROP PLUS SYSTEM PRESSURE DROP.
DHW SUPPLY
RELIEF VALVE
MODEL GB BOILER
3 WAY VALVE
AIR BLEED
VENT ELL
FLOW CHECK VALVE
STRAINER
P
* ZONES
WATER HEATER
FLOW CHECK VALVE
ZONE BALANCE VALVE
RETURN HEADER
GATE VALVE
DRAIN
FLOW CHECK VALVE
PRESSURE REDUCING VALVE
CITY WATER SUPPLY
FLOW CHECK VALVE
* - ZONES WITH CIRCULATION PUMPS. DOTTED LINE SHOWS ZONE WITH 3-WAY ZONE VALVE.
THIS SECTION OF PIPING NOT USED WITH 3-WAY ZONE VALVE CONTROL.

FIG 27.6. *Schematic shows three-way valve control of zones and water heating options.*

27.7. CHARGING BOILER SYSTEM WITH ANTIFREEZE

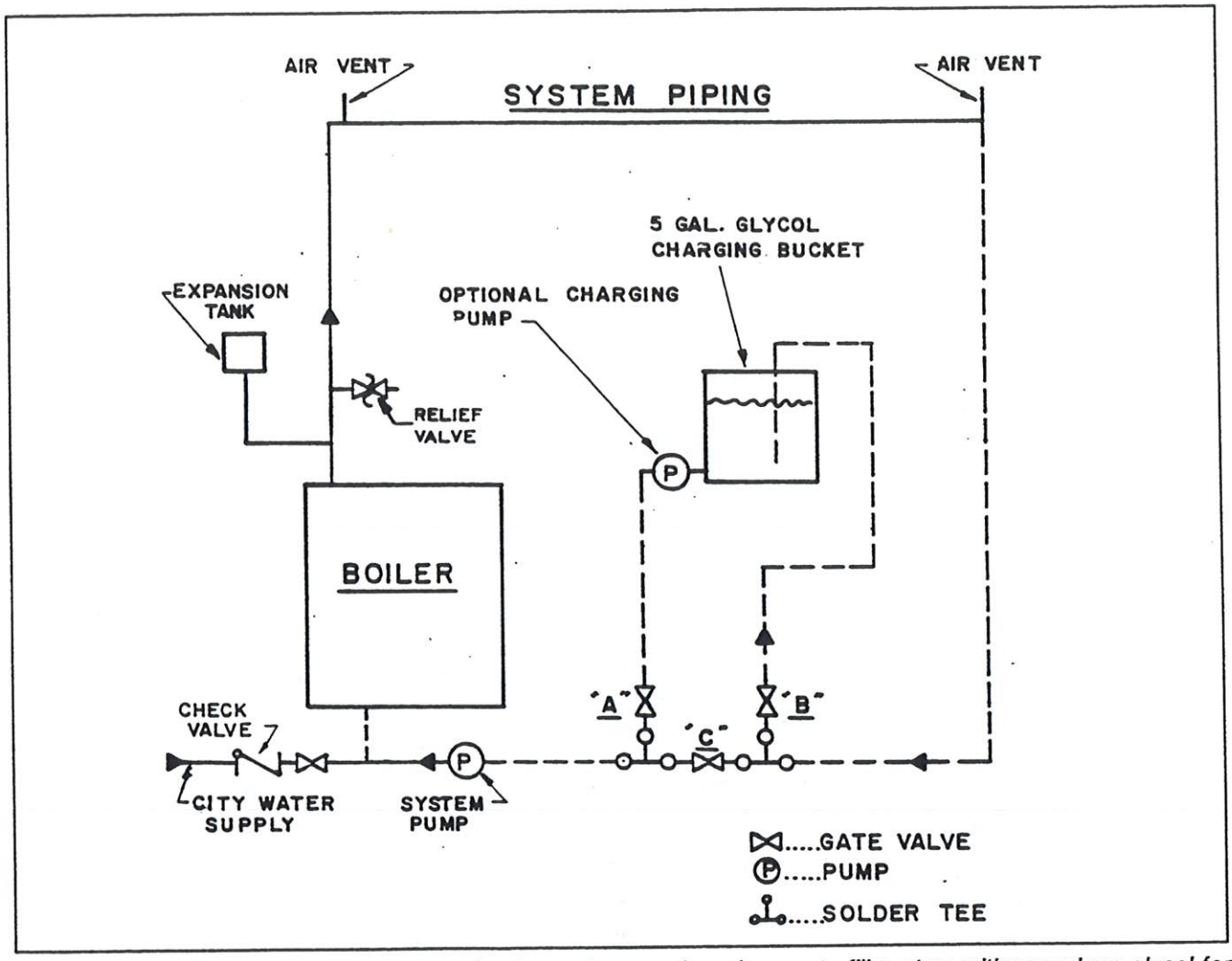
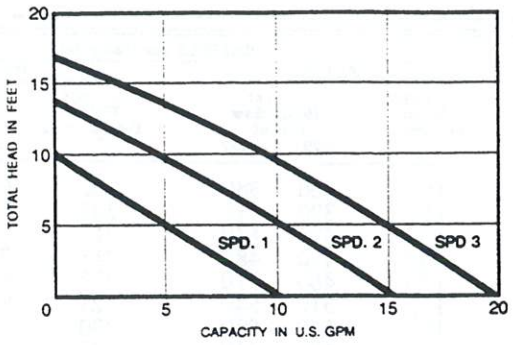


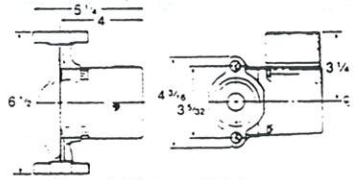
FIG. 27.7. *Schematic showing temporary hook-up of reservoir and pump to fill system with propylene glycol for freeze protection. Charging pump is optional if all radiation is below the boiler. Valves "A," "B," and "C" remain in the system permanently for subsequent recharging. See SEC. 3.1.3 for information regarding antifreeze solutions in boiler systems.*

28. GRUNDFOS PUMPS--PUMP PERFORMANCE DATA

UPS 15-42F (3-SPEED MOTOR) 60 Hz



DIMENSIONS (Inches)

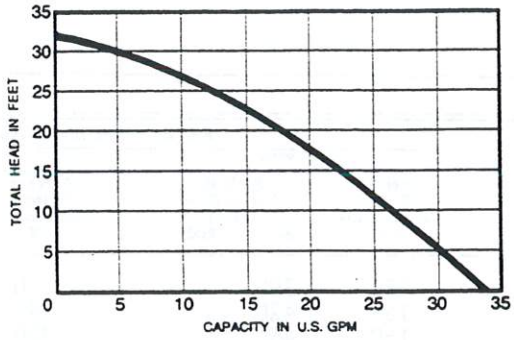


Connections: Flange (2) ½" diameter bolt holes.

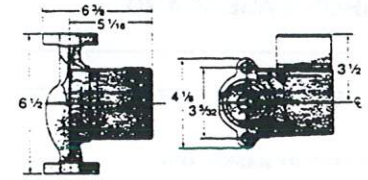
ELECTRICAL DATA
115 VOLT

SPEED	AMPS	WATTS	HP	CAPACITOR
3	.74	85	1/25	10μF/180V
2	.57	65	1/25	10μF/180V
1	.40	45	1/25	10μF/180V

UP 26-99F 60 Hz



DIMENSIONS (Inches)

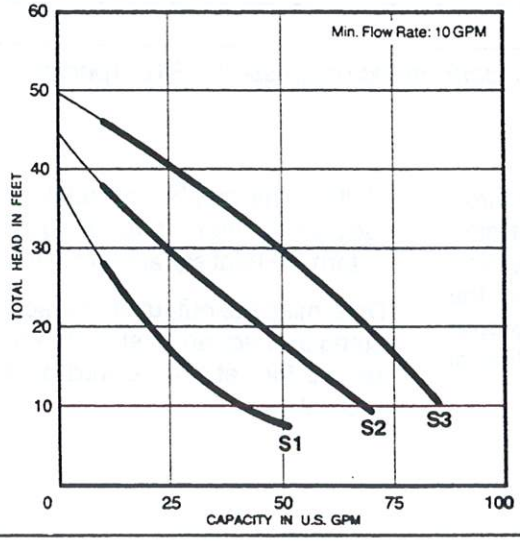


Connections: Flange (2) ½" diameter bolt holes.

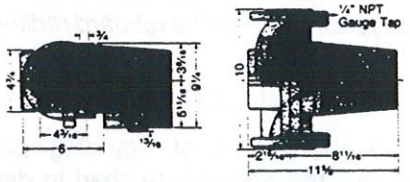
ELECTRICAL DATA

VOLTS	AMPS	WATTS	HP	CAPACITOR
115	2.15	245	1/6	10μF/180V

UPC 50-160 (SINGLE PHASE) 60 Hz



DIMENSIONS (Inches)



Net Wt.: 48.5 lbs. Connections: 2" ANSI 125 lb. R.F.

MINIMUM INLET PRESSURE

FLUID TEMP.	167°F	194°F	230°F
MINIMUM INLET PRESSURE	11.5 Ft.	23.0 Ft.	49 Ft.
	5.0 PSI	10.0 PSI	21.2 PSI

ELECTRICAL DATA

1 PH.	NOMINAL HP			F.L. AMPS		
VOLTAGE	SPD. 1	SPD. 2	SPD. 3	SPD. 1	SPD. 2	SPD. 3
115	1/8	½	¾	6.96	7.80	8.04

FIG 28. *Performance curves and physical dimensions for small Grundfos circulator pumps.*

29. RADIATION OUTPUT DATA

29.1. TYPICAL BASEBOARD RADIATOR OUTPUTS

29.1.1. COPPER FINNED TUBE RADIATION

DESCRIPTION OF BASEBOARD	RATINGS per linear foot WATER			WATER		
	Average Water Temperature ° F	Btuh at lb/hr. flow rate of 500	2000	Average Water Temperature ° F	Btuh at lb/hr. flow rate of 500	2000
¾" Copper Tubing Fins: Aluminum, 2-1/8" x 2-1/8" x .008" 60-62 fins per foot Height: 7 9/16"	150	360	380	200	670	710
	155	390	410	205	700	740
	160	420	440	210	730	770
	165	450	480	215	770	810
	170	480	510	220	800	850
	175	510	540	225	830	880
	180	550	580	230	860	910
	185	580	610	235	890	940
	190	610	640	240	920	970
	195	640	680			

FIG 29.1.1. *Output of typical standard copper finned-tube radiation at various delivery water temperatures expressed in BTUH per lineal foot of finned-tube.*

29.1.2. CAST IRON BASEBOARD

DESCRIPTION OF BASEBOARD	RATINGS per linear foot WATER			WATER		
	Average Water Temperature ° F	Btuh at lb/hr. flow rate of 500	2000	Average Water Temperature ° F	Btuh at lb/hr. flow rate of 500	2000
Cast Iron RC, kraft paper backing and/or Neoprene seal Height: 9¾"	150	390		190	640	
	155	420		195	670	
	160	450		200	700	
	165	480		205	730	
	170	510		210	760	
	175	540		215	800	
	180	570		220	830	
	185	600				

FIG. 29.1.2. *Typical cast iron baseboard radiation performance expressed in BTUH per lineal foot.*

29.2. CAST IRON RADIATORS

To determine the output of standing cast iron radiators, consult the appropriate chart to determine the number of square feet of radiation per section using the height and width of the radiator and the number of tubes per section as a guide to the proper chart. Values in the following charts list square feet of radiation per section.

Multiply the number of sections which make up the radiator by the number of square feet per section to determine total square feet in the particular radiator.

Determine the output of the radiator by multiplying the number of square feet by the heat emission rate per square foot at the desired design temperature from FIG. 29.2.2.

29.2.1. DETERMINING EQUIVALENT SQUARE FOOTAGE

29.2.1.1. COLUMN STYLE RADIATORS

SQ. FT. OF RADIATION PER SECTION

Width→ / Height In.	NO. OF COLUMNS 1	2	3	4	5	6
	4½"	7⅜"	9"	11½"	12½"	12½"
45"	3½	5	6	10	—	—
38"	3	4	5	8	10	—
32"	2½	3⅓	4½	6½	8½	—
26"	2	2⅔	3¾	5	7	7
23"	1⅔	2⅓	3¼	4½	—	—
22"	1⅔	2¼	3	4	6	6
20"	1½	2	2¾	3½	5	5
18"	1⅓	1¾	2¼	3	5	4⅓
17"	—	—	—	—	—	4
16"	—	—	—	—	4	3¾
15"	—	1½	—	—	—	—
14"	—	—	—	—	4	3
13"	—	—	—	—	3	3

FIG. 29.2.1.1. *Square feet of radiation per section in column style radiators.*

29.2.1.2. TUBE TYPE RADIATORS

SQ. FT. OF RADIATION PER SECTION

Width→ / Height In.	NO. OF TUBES 3	4	5	6	7
	5"	7"	8¾"	9¾"	12½"
38"	3½	4¼	5	6	—
36"	3½	4¼	5	6	7
32"	3	3½	4⅓	5	6
26"	2⅓	2¾	3½	4	5
23"	2	2½	3	3½	4½
22"	—	—	—	—	4½
20"	1¾	2¼	2⅔	3	3⅔
18"	—	—	—	—	3½
17"	—	—	—	—	3
16"	—	—	—	—	3
14"	—	—	—	—	2½

FIG. 29.2.1.2. *Square feet of radiation per section in tube type radiators.*

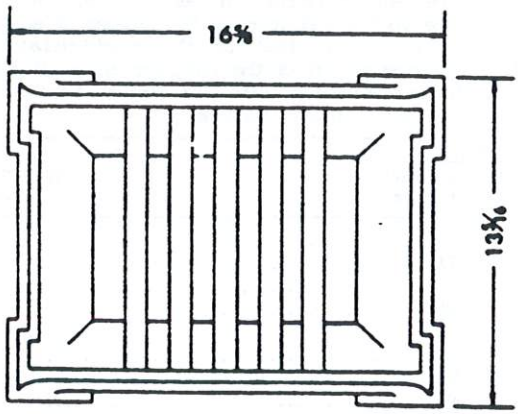
29.2.1.3. THIN TUBE TYPE RADIATORS

SQ. FT. OF RADIATION PER SECTION

	NO. OF TUBES				
	2	3	4	5	6
Width→	3½"	4"	4¾"	6"	7⅞"
Height In.					
38"	2.5	2.6	—	—	—
32"	2.0	2.4	—	—	3.7
26"	—	—	2.4	3.0	3.0
25"	1.6	1.6	2.0	—	3.0
23"	—	—	—	2.1	—
22"	1.3	1.4	1.8	—	—
20"	—	—	1.8	—	2.3
19"	1.1	1.2	1.6	—	2.3
17"	—	—	—	2.0	—

FIG. 29.2.1.3. *Square feet of radiation per section in thin tube type radiators.*

29.2.1.4. WALL TYPE CAST IRON RADIATORS



Size Shown 5 Sq. Ft. Radiation

SQ. FT. RADIATION PER WALL RADIATOR SECTION

Type of Section	Height Inches	Length or Width, In.	Thickness Inches	Heating Sq. Ft. Radiation
5-A	13⅜	16⅝	2⅞	5
7-A	13⅜	21⅞	2⅞	7
7-B	21⅞	13⅜	3⅛	7
9-A	18⅝	29⅛	2⅞	9
9-B	29⅛	18⅝	3 11/16	9

FIG. 29.2.1.4 *Square feet of radiation per section in wall type radiators.*

29.2.2. HEAT EMISSION RATES OF CAST IRON

To determine the output of standing cast iron radiators, consult the appropriate chart to determine the number of square feet of radiation per section using the height and width of the radiator and the number of tubes per section as a guide to the proper chart. Values in the following charts list square feet of radiation per section. Multiply the number of sections which make up the radiator by the number of square feet per section to determine total square feet in the particular radiator.

Determine the output of the radiator by multiplying the number of square feet by the heat emission rate per square foot at the desired design temperature from FIG. H.2.1, below.

Design or Average Water Temperature	Heat Emission Rates Btuh per sq. ft.
170	150
175	160
180	170
185	180
190	190
195	200
200	210
205	220
210	230
215	240

FIG. 29.2.2. *Heat emission rates for cast iron radiators at various design temperatures.*

30. MULTIPLE BOILER SCHEMATICS

A seemingly infinite number of permutations of the GlowCore multiple boiler concept with both heat and/or domestic hot water are possible. Water flow through the boiler and heat exchangers is critical. Be sure the distribution system is capable of dissipating all the heat produced to prevent needless cycling of the boilers on their limits and to produce optimum efficiencies from the system.

30.1 BOILERS WITH SINGLE SYSTEM PUMP

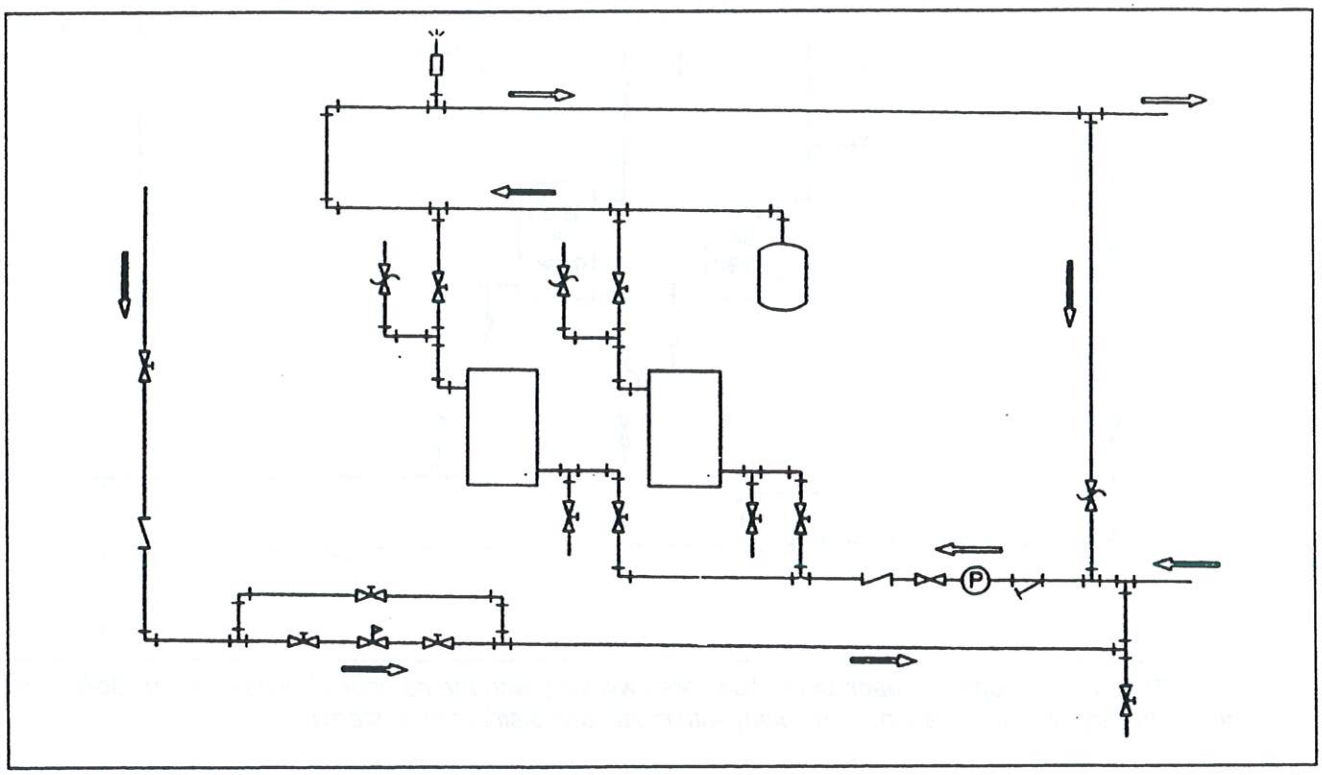


FIG. 30.1 *Boilers can be staged on or off according to load. Single pump must overcome system head at the combined flow of the two boilers and run when either of the boilers or both run. The temperature rise measured across the boilers will vary with the number of boilers fired since flow will be constant.*

30.2 BOILERS INDIVIDUALLY PUMPED

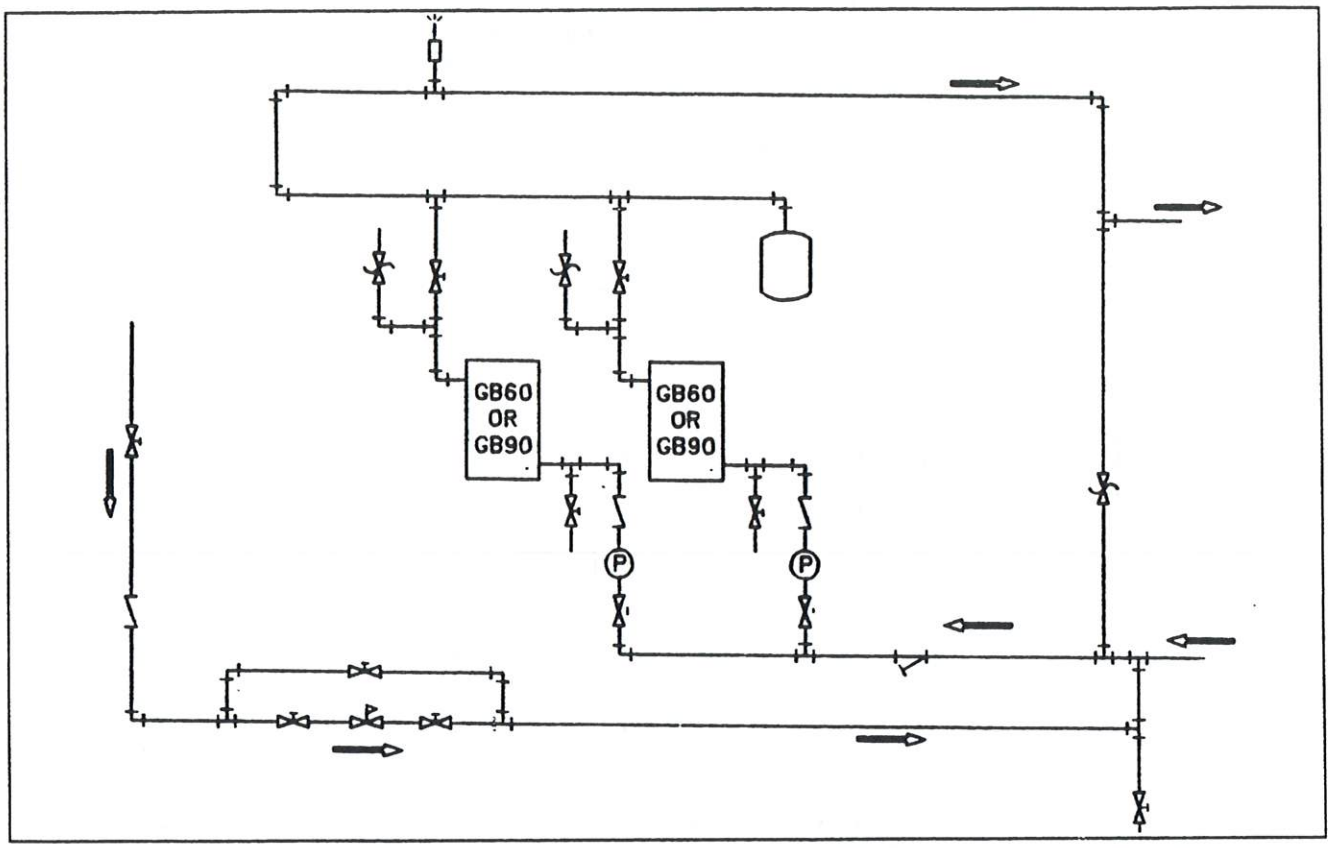


FIG. 30.2 *With a pump for each boiler flow rates will vary with the number of units running. Boiler system can adjust to varying load situations particularly with multi-zone distribution systems.*

30.3 GB16014 WITH SERIES PUMPING

Pumps may be used in series in boiler systems requiring higher head pumps. Available head of the two pumps will almost double at a given flow rate when two are installed in series.

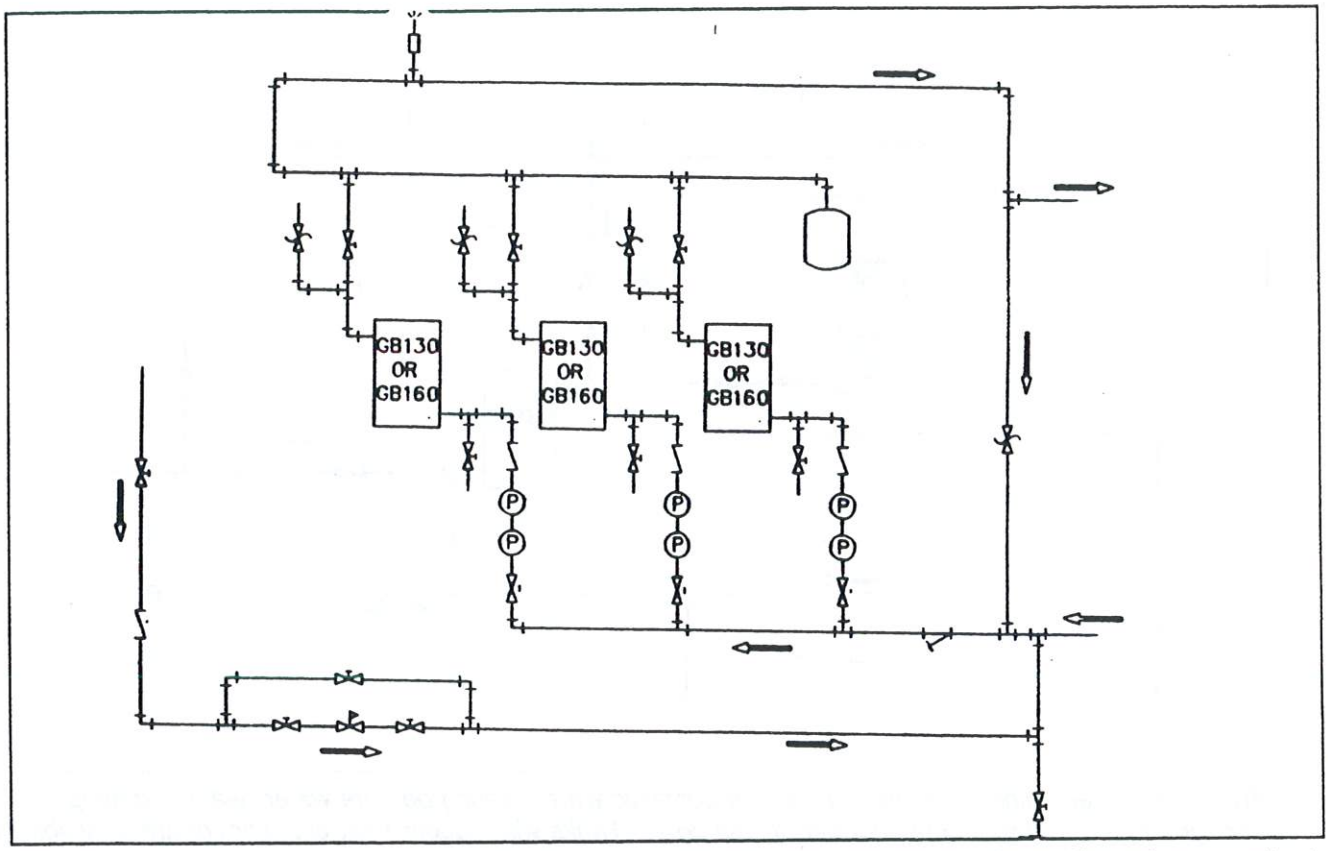


FIG. 30.3 *Multiple boilers systems have characteristics of both series and parallel flows. Use a bypass valve to insure proper flows through the boilers under all conditions.*

30.4 WATER HEATING SCHEMATICS

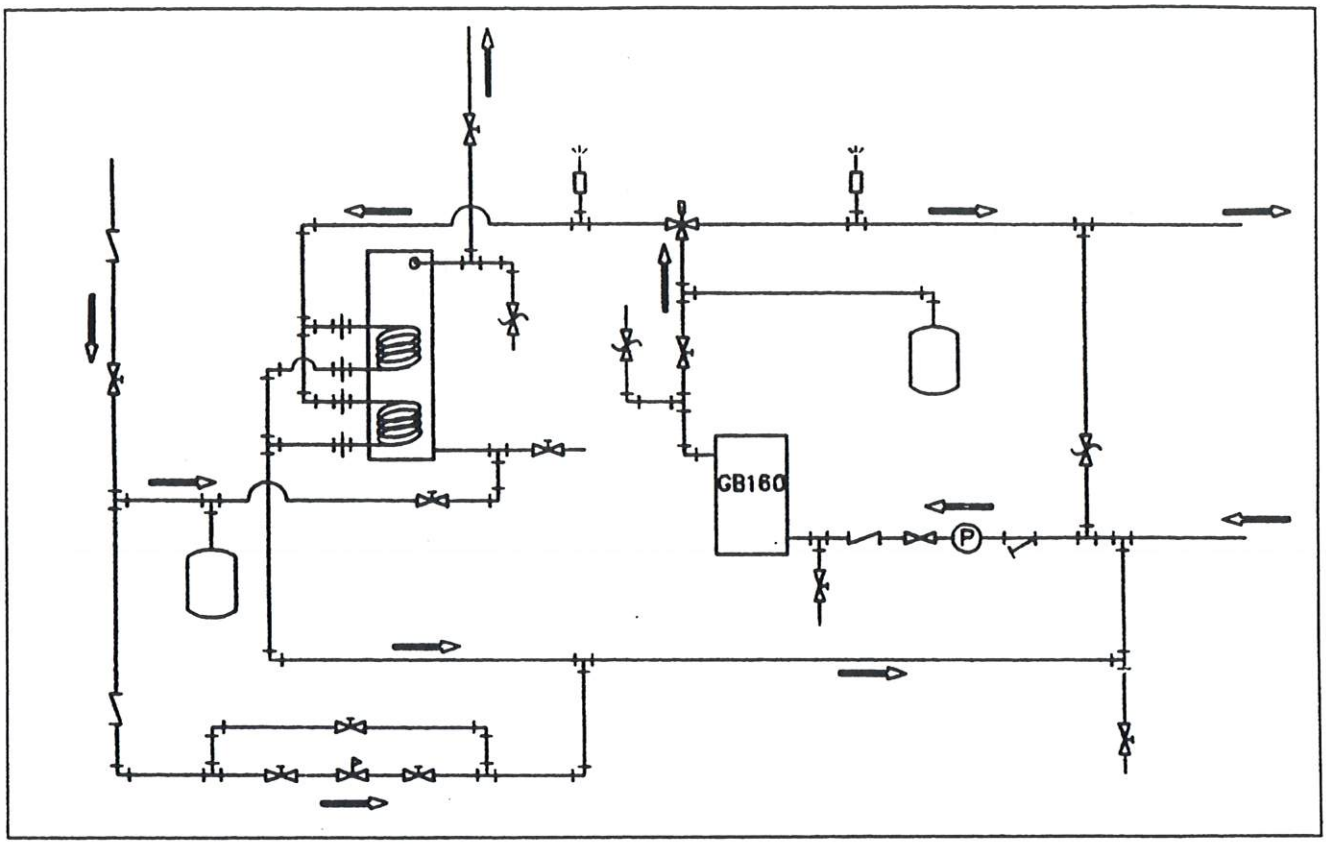


FIG. 30.4 *When using a GB16014 boiler for domestic water heating be sure water heater exchanger is large enough to permit proper flow and load to the boiler. Tanks with double heat exchangers are available which present proper amounts of surface area for the output of the GB160 boiler.*

30.5 DUAL TANK STORAGE

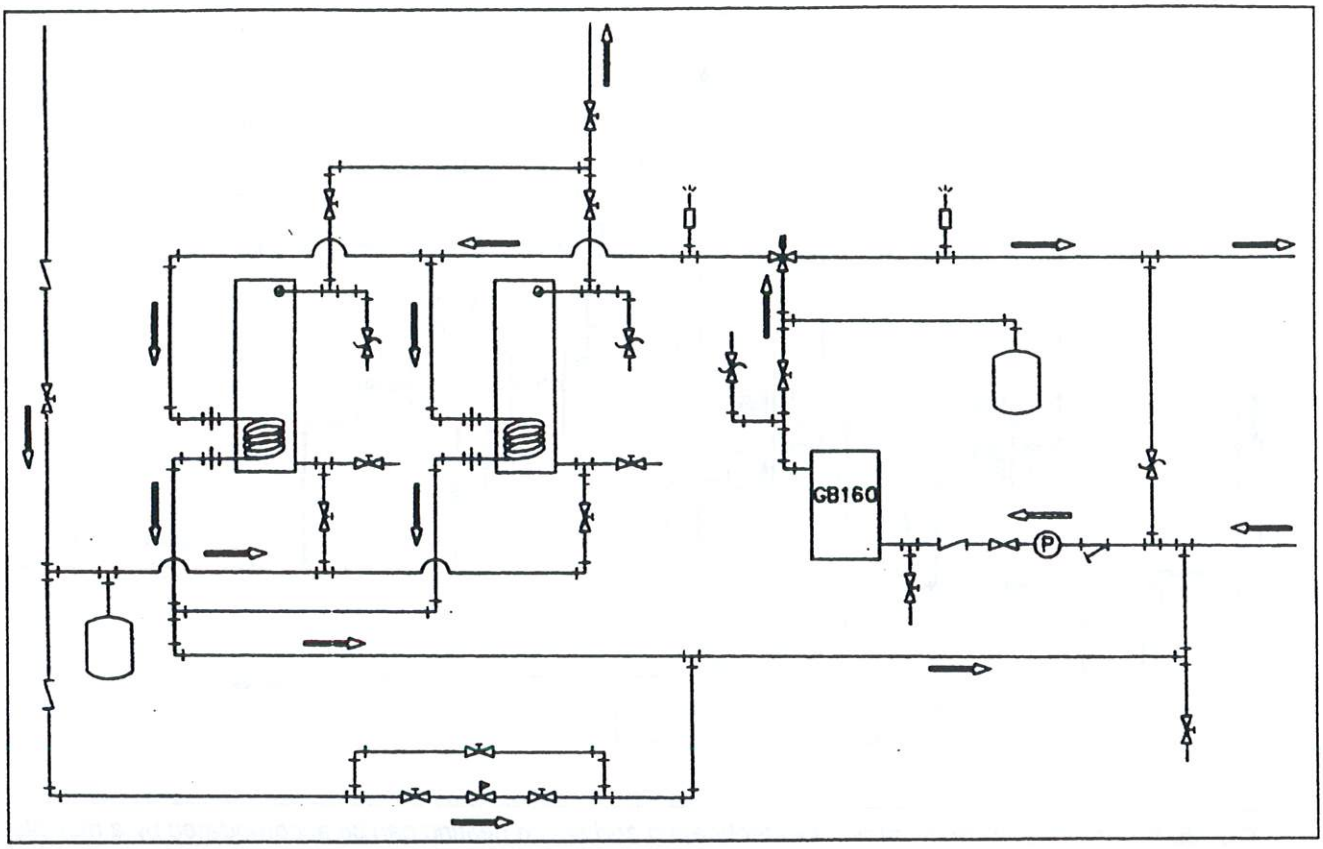


FIG. 30.5 *If more storage is required two or more tanks can be piped in parallel. Note that the two heat exchangers are piped in parallel and will present about the same load and flow characteristics as the double exchanger tank but with a greater storage capacity and better response to peak loads.*

30.6 MULTIPLE BOILERS WITH MULTIPLE WATER HEATERS

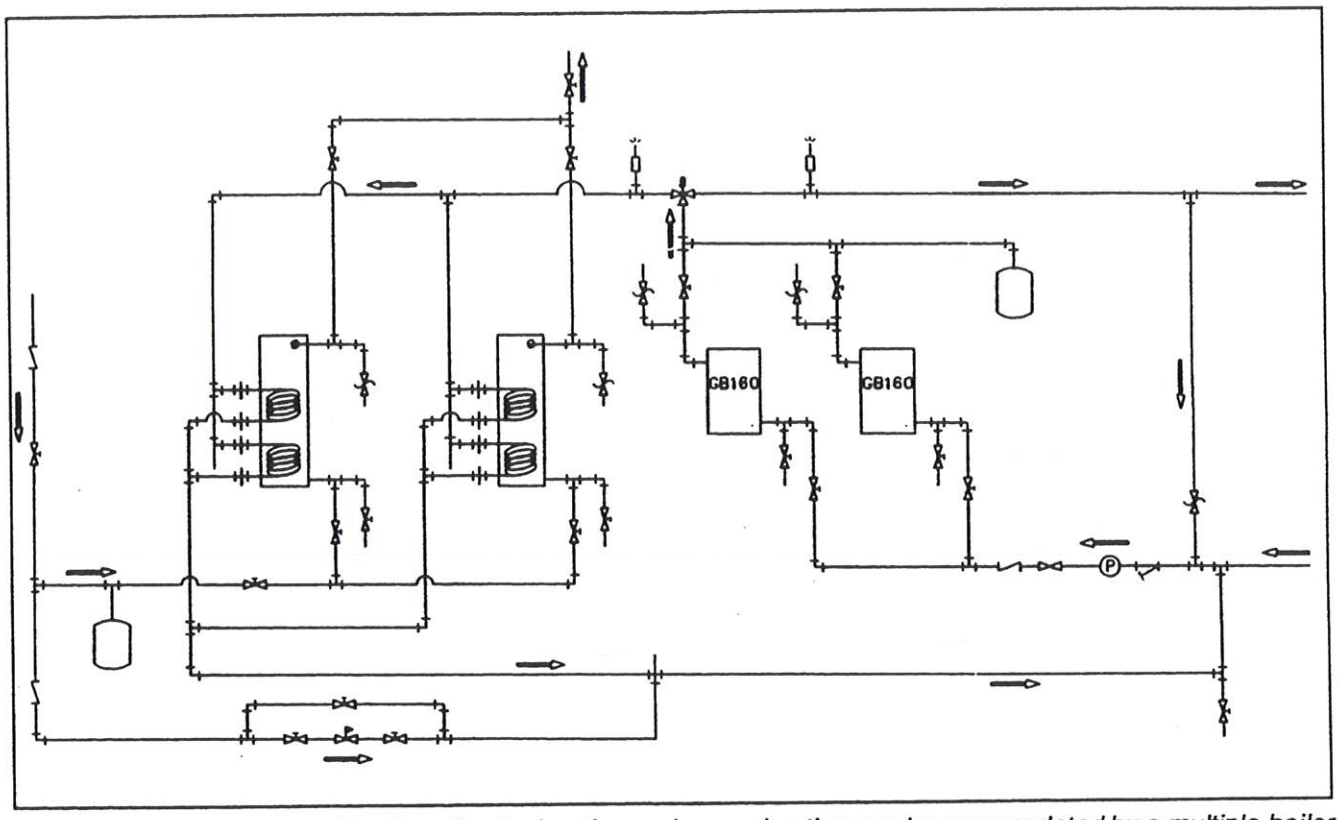


FIG. 30.6 *Virtually any combination of water heating and space heating can be accomodated by a multiple boiler system.*

30.7 HYDRONIC WARM AIR COMBINATIONS

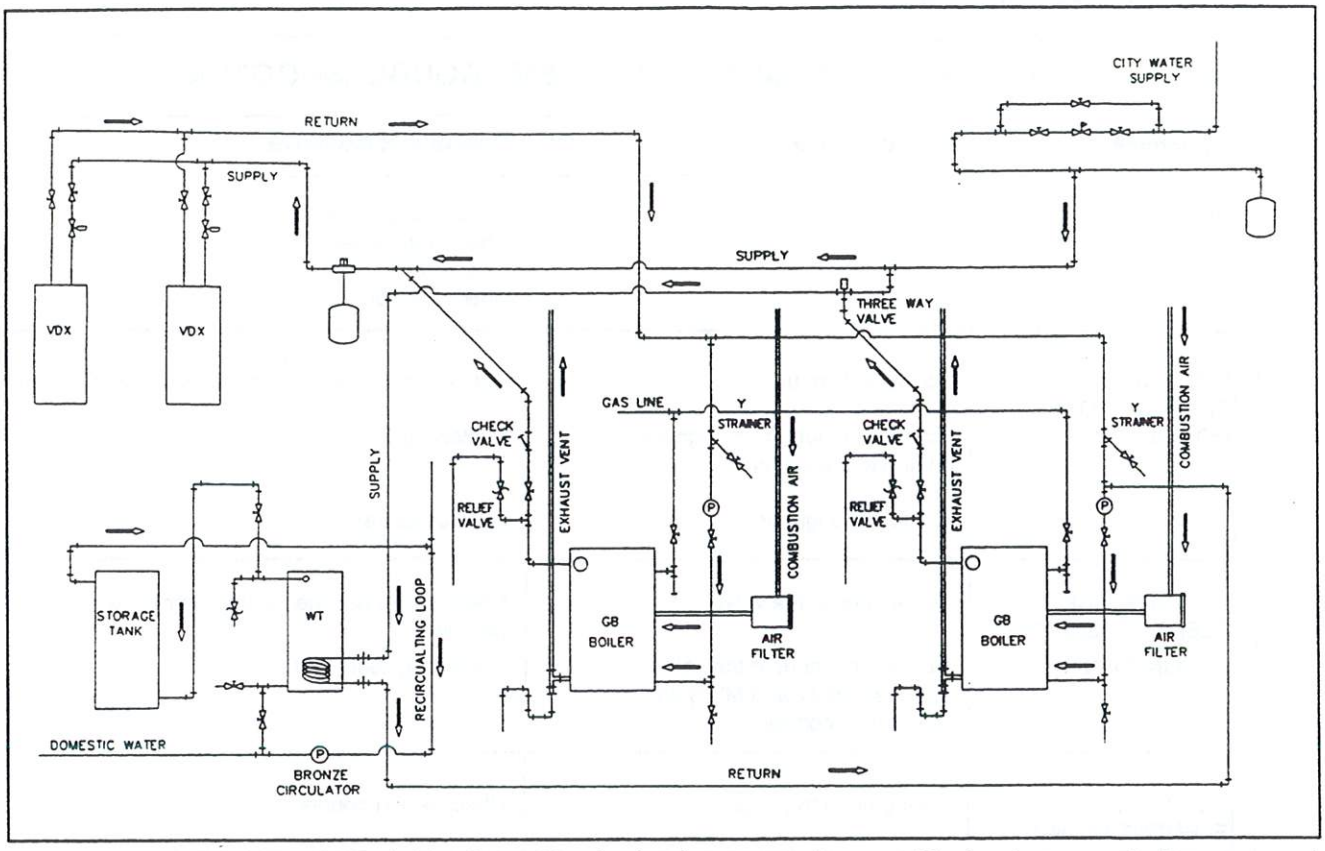


FIG. 30.7 *Using VDX or HWF air handlers with a hydronic system also a multitude of uses and allows warm air systems to be zoned for both heating and cooling. Pool heaters may also be added to these types of systems.*

31.0 TROUBLESHOOTING

31.1 HOT SURFACE IGNITION

HOT SURFACE IGNITION SYSTEM TROUBLESHOOTING

Symptoms	Possible Cause	Checks and Remedies
DEAD	No 24 volt input	Check system wiring Check thermostat Check transformer Check control circ.
HOT SURFACE ELEMENT DOES NOT GLOW	No 120 volt input	Check circuit breaker and 120 volt power source
	No 120 volt output from ignition control to the igniter	Replace ignition control
	Crack in the igniter	Replace igniter
HOT SURFACE ELEMENT GLOWS— NO IGNITION	No 24 volts at the valve	Check wiring between ignition control and gas valve
	No 24 volt output at the valve terminals (MV1 and MV2) on the ignition control	Replace ignition control
HOT SURFACE ELEMENT GLOWS, 24 VOLTS TO GAS VALVE, FLAME IS ESTABLISHED, BUT GOES OUT AFTER 7 SECONDS	Poor ground to the unit	Check wiring connections
	Improperly located electrode	Check for correct length electrode
	Hairline crack in electrode	Replace
HOT SURFACE ELEMENT GLOWS, 24 VOLTS TO GAS VALVE, SYSTEM FAILS TO LIGHT	Combustion out of adjustment	Check for correct size gas and air orificies. Check for proper gas pressure
	Plugged or restricted burner	Clean or replace
	Improperly located electrode	Check for correct length electrode

31.2 GB BOILER TROUBLESHOOTING

Symptoms	Possible Cause	Checks and Remedies
UNIT CYCLING ON COMBUSTION AIR PRESSURE SWITCH (APS)	Excessive equivalent length of intake/vent piping	Refer to installation/operating instructions (Section on Venting)
	Dirty/obstructed burner or heat exchanger	Visually inspect/check pressure drop
	Obstructed condensate drain	Visually inspect/repair as required
	Slow Combustion Air Blower	Check motor amp draw
	Defective APS	Visually inspect/check operating differential
	Sea level APS on high altitude application	Refer to high altitude kit for unit
	Obstructed intake or vent piping	Visually inspect and correct as required
	Leaking connections to APS	Visually inspect and correct as required
UNIT LIGHTS AND GOES OUT	Recirculating flue gases	Visually inspect or operate with indoor air
	Fluctuating gas press	Check with manometer
	Defective APS	Check for proper pressure differential
	Undersized gas line	Check manometer/refer to pipe sizing table
	Cycling on safety or operating controls	Check operation of controls
	Loose electrical connection(s)	Check with ohmeter/voltmeter
	Incompatible external control system	Refer to control manufacturer's instructions
DELAYED (NOISY) IGNITION	High/low gas pressure	Clock gas meter/perform CO_2 test/check with manometer
	Fluctuating gas pressure	Check with manometer during ignition sequence
	Incorrect gas/air orifices	Visually inspect per instruction
	Dirty burner/heat exchanger	Visually inspect/check pressure drop
EXCESSIVE BURNER CYCLING	Insufficient radiation	Check actual amount of radiation per zone and refer to manufacturer's rating tables
	Undersized pump(s)	Check manufacturer's rating charts/check Δ_t through heat exchanger
	Improper piping	Refer to GlowCore's recommended piping manual
	Restriction in piping	Check Δ_t across zone in question/check Δ_t across heat exchanger
	Unit overfired	Clock gas meter/perform CO_2 test/check gas pressure with manometer
	Improperly set or defective operating/safety control(s)	Check operation with ohmeter/voltmeter
	Dirty burner/heat exchanger	Visually inspect/check pressure drop per table
	Loose electrical connection	Check with ohmeter/voltmeter
	Thermostat improperly installed	Check manufacturer's instructions for proper installation

Symptoms	Possible Cause	Checks and Remedies
EXCESSIVE BURNER CYCLING (cont.)	Unit oversized	Refer to load calculation vs. boiler output
	Thermostat defective/improper inticipator setting	Check operation per manufacturer's instructions/ check setting with ammeter
	Antifreeze added to system	Refer to section regarding introduction of antifreeze to system
	Air in system	Bleed/purge system as required
	Incorrect gas/air orifices	Visually inspect per schedule
	Improper intake/vent piping	Refer to installation/operating instructions
	Obstructed condensate drain	Visually inspect
EXCESSIVE FUEL CONSUMPTION	Unit overfired	Clock gas meter/perform CO_2 test
	Leak in tank or piping (LP)	Refer to fuel supplier for inspection
	Excessive heat loss	Refer to load calculation
	Excessive water consumption	Review water heating demand
	Defective gas meter	Refer to gas supplier for inspection
INSUFFICIENT HOT WATER	Excessive peak demand	Review application
	Excessive flow rate	Check flow rate vs. specifications
	Poor heat transfer through WT heat exchanger	Check water hardness/check Δ_t across heat exchanger
	Improper operating limit setting	Check setting—set at E
	Improper tank thermostat setting	Check setting—set at 130°
	Excessive tank thermostat differential	Check operating differential
	Leaking three way valve	Check for water leakage through zones
	Erratic operation of tank thermostat	Check operation
	Improper insertion of thermostat sensing bulb into tank well	Check for proper insertion
	Undersized tank	Review application
	Poor boiler combustion	Perform CO_2 test
	Insufficient water flow rate to water tank heat exchanger	A—Undersized innerconnecting piping B—Undersized circ./main pump C—Excessive head loss
UNIT WILL NOT OPERATE	Blown fuse	Remove/replace and check circuit amp draw
	Loose electrical connection	Check with voltmeter/ohmeter
	Defective space thermostat	Check operation per manufacturer's instructions
	Improperly set thermostat	Check and set per manufacturer's instructions
	Defective transformer	Check output with voltmeter

Symptoms	Possible Cause	Checks and Remedies
UNIT WILL NOT OPERATE	Open excessive temperature switch	Check output with voltmeter/ohmeter
	Open water pressure switch	Check output with voltmeter/check PRV setting
	Open R1 relay coil/contacts	Check output with ohmeter/voltmeter
INSUFFICIENT HEAT	Unit oversized/undersized	Refer to load calculation vs. unit output
	System radiation undersized	Check manufacturer's rating tables for capacity per foot
	Air trapped within system	Bleed system as required
	Unit underfired	Perform CO_2 test
	Improper system piping	Refer to GlowCore Recommended Piping Manual
	System pump(s) undersized	Check pump manufacturer's data/ check Δ_t across heat exchanger
	Poor combustion	Perform CO_2 test
	Defective thermostat	Check per manufacturer's instructions
	Incorrect gas/air orifices	Visually inspect per orifice schedule
	Obstructed condensate drain	Visually inspect and clean as requested
	Unit cycling on operating/safety controls	Check operation with ohmeter/voltmeter
FUMES AND HIGH HUMIDITY	Improperly installed condensate trap	Refer to installation/operating instructions
	Leak in PVC/CPVC vent piping	Visually inspect with soap solution
	Flue gas leak in heat exchanger	Visually inspect all mechanical connections
TEMPERATURE OVERRIDES	Incorrect thermostat anticipator setting	Check with ammeter/microammeter
THERMOSTAT	Thermostat not level	Check level
SETTING	Thermostat out of calibration	Check per manufacturer's instructions
ONE OR MORE ZONES	Air trapped within zone(s) piping	Vent system/zone as required
DO NOT HEAT PROPERLY	Insufficient radiation/excessive heat loss	Check actual length of radiation/heat loss calculation
	Insufficient flow rate to zone(s)	Check temperature drop across zone
	Defective zone valve/zone circulator	Check operation per manufacturer's instructions
	Defective zone thermostat	Check operation per manufacturer's instructions
	Improper control wiring	Check wiring per manufacturer's instructions
	Improper/obstructed baseboard radiation	Check baseboard manufacturer's instructions/check at zone
	Operating limit set improperly	Check limit setting/operation

31.3 UF FURNACE TROUBLESHOOTING

Symptoms	Possible Cause	Checks and Remedies
UNIT CYCLING ON COMBUSTION AIR PRESSURE SWITCH (APS)	Excessive equivalent length of intake/vent piping	Refer to installation/operating instructions
	Dirty/obstructed burner or heat exchanger	Visually inspect/check pressure drop
	Obstructed condensate drain	Visually inspect/repair as required
	Slow Combustion Air Blower	Check motor amp draw
	Defective APS	Visually inspect/check operating differential
	Obstructed intake or vent piping	Visually inspect and correct as required
	Leaking connections to APS	Visually inspect and correct as required
UNIT LIGHTS AND GOES OUT	Recirculating flue gases	Visually inspect or operate with indoor air
	Improper/insufficient flame signal to ignition control	Inspect igniters/check flame signal
	Fluctuating gas press	Check with manometer
	Defective APS	Check for proper pressure differential
	Undersized gas line	Check manometer/refer to pipe sizing table
	Cycling on safety or operating controls	Check operation of controls
	Loose electrical connection(s)	Check with ohmeter/voltmeter
DELAYED (NOISY) IGNITION	High/low gas pressure	Clock gas meter/perform CO_2 test/check with manometer
	Fluctuating gas pressure	Check with manometer during ignition sequence
	Improperly positioned or defective ignitor	Visually inspect for damage
	Incorrect gas/air orifices	Visually inspect
	Dirty burner/heat exchanger	Visually inspect/check pressure drop per table
EXCESSIVE BURNER CYCLING	Insufficient air flow, dirty air filter	Check air filter; clean filter and/or hot water
	Dirty hot water coil	Replace impeller on water pump
	Broken impeller vanes	Replace impeller on water pump
	Improper piping	Refer to GlowCore's recommended piping manual
	Unit overfired	Clock gas meter/perform CO_2 test/check gas pressure with manometer
	Improperly set or defective operating/safety control(s)	Check operation with ohmeter/voltmeter
	Dirty burner/heat exchanger	Visually inspect/check pressure drop
	Loose electrical connection	Check with ohmeter/voltmeter
	Thermostat improperly installed	Check manufacturer's instructions for proper installation
	Unit oversized	Refer to load calculation vs. boiler output
	Thermostat defective/improper inticipator setting	Check operation per manufacturer's instructions/ check setting with ammeter

Symptoms	Possible Cause	Checks and Remedies
EXCESSIVE BURNER CYCLING (cont.)	Air in system	Bleed/purge system as required
	Incorrect gas/air orifices	Visually inspect per schedule
	Improper intake/vent piping	Refer to installation/operating instructions
	Obstructed condensate drain	Visually inspect
EXCESSIVE FUEL CONSUMPTION	Unit overfired	Clock gas meter/perform CO_2 test
	Leak in tank or piping (LP)	Refer to fuel supplier for inspection
	Excessive heat loss	Refer to load calculation
	Excessive water consumption	Review water heating demand
	Defective gas meter	Refer to gas supplier for inspection
INSUFFICIENT HOT WATER	Excessive peak demand	Review application
	Excessive flow rate	Check flow rate vs. specifications
	Poor heat transfer through WT heat exchanger	Check water hardness/check Δ_t across heat exchanger
	Improper operating limit setting	Check setting—set at E
	Improper tank thermostat setting	Check setting
	Excessive tank thermostat differential	Check operating differential
	Leaking three way valve	Check for water leakage through zones
	Erratic operation of tank thermostat	Check operation
	Improper insertion of thermostat sensing bulb into tank well	Check for proper insertion
	Undersized tank	Review application
	Poor combustion	Perform CO_2 test
	Insufficient water flow rate to water tank heat exchanger	A—Undersized innerconnecting piping B—Excessive head loss
UNIT WILL NOT OPERATE	Blown fuse	Remove/replace and check circuit amp draw
	Loose electrical connection	Check with voltmeter/ohmeter
	Defective space thermostat	Check operation per manufacturer's instructions
	Improperly set thermostat	Check and set per manufacturer's instructions
	Defective transformer	Check output with voltmeter
	Open excessive temperature switch	Check output with voltmeter/ohmeter
	Open water pressure switch	Check output with voltmeter/check PRV setting
	Open R1 relay coil/contacts	Check output with ohmeter/voltmeter
UNIT RUNS BUT WILL NOT IGNITE	Open operating/safety control	Check operation with ohmeter/voltmeter
	Gas supply shut off	Check with manometer
	High/low gas pressure	Check with manometer
	Defective or improperly set igniter/sensor assembly	Visually inspect/adjust as required

Symptoms	Possible Cause	Checks and Remedies
UNIT RUNS BUT WILL NOT IGNITE (cont.)	Incorrect gas/air orifices	Visually inspect per schedule
	Obstructed intake/vent piping	Visually inspect
	Obstructed condensate drain	Visually inspect
	Defective gas valve	Check operation with voltmeter/manometer
	Dirty burner/heat exchanger	Visually inspect/check pressure drop per table
INSUFFICIENT HEAT	Unit oversized/undersized	Refer to load calculation vs. unit output
	Air trapped within system	Bleed system as required
	Unit underfired	Perform CO_2 test
	Poor combustion	Perform CO_2 test
	Defective thermostat	Check per manufacturer's instructions
	Incorrect gas/air orifices	Visually inspect per orifice schedule
	Obstructed condensate drain	Visually inspect and clean as requested
	Unit cycling on operating/safety controls	Check operation with ohmeter/voltmeter
FUMES AND HIGH HUMIDITY	Improperly installed condensate trap	Refer to installation/operating instructions
	Leak in PVC/CPVC vent piping	Visually inspect with soap solution
	Flue gas leak in heat exchanger	Visually inspect all mechanical connections
TEMPERATURE OVERRIDES THERMOSTAT SETTING	Incorrect thermostat anticipator setting	Check with ammeter/microammeter
	Thermostat not level	Check level
	Thermostat out of calibration	Check per manufacturer's instructions
EXCESSIVE BLOWER CYCLING	Defective fan switch	Remove/replace
	Blower motor trips overload	Check amp draw and compare to manufacturer's specs. Replace if necessary.
	Low voltage to motor	Check voltage
	Loose electrical connection	Check and tighten connections
FAN SHORT CYCLES AT END OF WATER HEATING CYCLE	Improperly wired DVUF kit	Check wiring diagram
	Old style DVUF kit installed	Consult factory for parts to update existing kit
	Yellow wire not removed from terminal no. 5 on water circulating switch	Remove and tape securely

Symptoms	Possible Cause	Checks and Remedies
EXCESSIVE BLOWER NOISE	Blower wheel loose on motor shaft	Tighten set screws
	Blower running too fast	Check CFM, temperature rise, and adjust speed accordingly
	Vibrating or undersized duct work	Evaluate duct work and correct if required
	Damaged or unbalanced blower wheel	Replace
	Blower motor bearing worn	Replace
	Noisy blower motor	Replace
	Blower compartment door not secured	Secure door
AIR NOISE FROM REGISTER	Register too small or partially closed	Determine CFM requirement and balance or replace register
	Wrong type register	Check for vibrating vanes. Replace if required.
	Air velocity too great	Reduce fan speed and/or increase duct size
UNEVEN SPACE TEMPERATURES	Air distribution system not balanced	Balance system by adjusting dampers
	Thermostat location	Refer to T/S manufacturer's installation instructions
	Blocked cold air return	Check return

31.0 WST SERIES WATER HEATER

Indirect-fired water heaters offer a number of advantages over direct-fired water heaters including generally higher capacities, less maintenance since only the boiler's burner needs to be serviced, no venting required, and greatly reduced standby losses.

The GlowCore WaterCore (WST series) water heater represents a breakthrough in indirect water heater design and offers advantages over other types of indirect-fired water heaters including serviceability of the heat exchanger.

The water-to-water heat exchanger is located outside of the water tank mounted on top of the tank for easy access. Costly stainless steel and the welding processes involved in installing the heat exchanger within the tank are eliminated and lower costs can be achieved. The heat echanger can be removed and cleaned or replaced when necessary, though the exchanger is designed to prevent scaling by maintaining good velocities and turbulence through the exchanger. In certain high lime regions of the country some liming may still occur.

Because the unit is indirectly-fired, lime formations do not harden as in direct-fired tanks with their inherently higher exchanger surface temperatures.

31.1 HEAT EXCHANGER

The WST series exchanger is a copper tube-in-tube design. THe inner heat echanger tube carries boiler water and the annulus (the area between the inner and outer tubes) carries the domestic water in a counterflow pattern.

The boiler water is pumped through the innner passage of the heat exhanger by the boiler's circulator and a small (1/25th horsepower) bronze pump circulates water from the tank through the outer heat exchanger passage. On a call for heating from the tanks's surface mounted aquastat, a relay is energized which starts the bronze pump and the diverter valve and/or boiler. Water is drawn off the bottom of the tank, pumped through the heat exchanger, and returned to the middle of the tank while boiler water flows in the opposite direction through the inner passageway.

The inner tube of the heat exchanger is a spiral copper design which provides greater heat exchanger surface area and increases the turbulence to help prevent liming and increase heat transfer. When water is drawn from the tank some or all of the incoming cold water (depending on the rate of draw) is pumped through the heat exchanger directly increasing the temperature differential between the boiler water and the domestic water and improves the heat transfer rate. This greater temperature differential also increases the boiler's ability to give up heat and consequently maintains peak boiler efficiency. When the call for domestic water heating is satisfied both the boiler and the water heater pump are de-energized until the next call for domestic water heating.

31.2 TANK CONSTRUCTION

The WST series tank is completely surrounded by 2" of urethane foam insulation leading to minimal standby losses (about 1 degree F. per hour) and there is no flue to allow the escape of heat up the chimney during the off cycle. The tank is glass-lined and includes a replaceable anode rod to protect the tank from pitting and subsequent leaking. The anode rod is connected to the hot water outlet nipple and is immersed in the water in the tank.

31.3 PIPING CONNECTIONS

All piping fittings for the tank are located on the top, unlike the former WT series, allowing the installer greater flexibility in the location of the tank. A tapping is provided in the side of the tank for the required temperature and pressure relief valve and a drain cock is provided at the bottom of the tank.

1" copper unions are provided on the top of the tank for boiler hook-up and 3/4" male pipe threads are provided for domestic water hook-up.

31.4 SYSTEM DESIGN

Pressure drops for the WST series heat exchanger are considerably less than for the WT series tank: about 6.9 feet of water column pressure drop at 8 gallons per minute as compared with the WT's 13 feet of water column pressure drop at 8 gallons per minute. Piping design is therefore somewhat more flexible and low water flow problems associated with the WT series tanks, particularly with the UF furnace's internal water circulator, are largely eliminated. Recommended pipe sizing between the boiler and the water heater is minimum 1"

31.5 ELECTRICAL

A 120 volt circuit must be run to the water tank to power the internal circulator. Hard wiring or a cordset may be used as desired or required by local codes. A 24 volt control circuit must be run from the water tank to the boiler or diverter valve and may be powered by the same transformer installed for the diverter valve.

WST SERIES FEATURES

- Tank — Glass Lined
- Thermostat — Anode Rod
- Heat Exchanger — Copper
- Insulation — Polyurethane Foam
- Pump to Circulate Tank Water to Heat Exchanger: .54 amps/110 v.

SPECIFICATIONS

Model No.	WST-40
Domestic Tank Capacity	40 Gal.
Dimensions H x W (in.)	55 x 20
Ship. Wt. (lbs.)	130
Test Pressure	300 PSI
Working Pressure	150 PSI

MINUTES OF WATER DRAW AT 140°F (FOR PERFORMANCE AT 115°F MULTIPLY BY 1.56)

Tank Model No.	Flow - G.P.M 2	3	4	5	Input BTUH
WST-40	10.5	7.8	5.1	4.8	60,000
	12.6	8.3	6.9	5.4	80,000
	∞*	9.1	6.8	5.5	90,000

* INFINITY — WST-40 will supply 140°F hot water at two gallons per minute forever with 90,000 BTUH input @ 55°F inlet water temperaturer.

CONTINUOUS DUTY RATINGS — OUTLET WATER °F @ 55°F INLET WATER TEMPERATURE

Tank Model No.	Flow - G.P.M 2	3	4	5	Input BTUH
WST-40	109	91	82	77	60,000
	125	102	90	83	80,000
	135	108	95	87	90,000

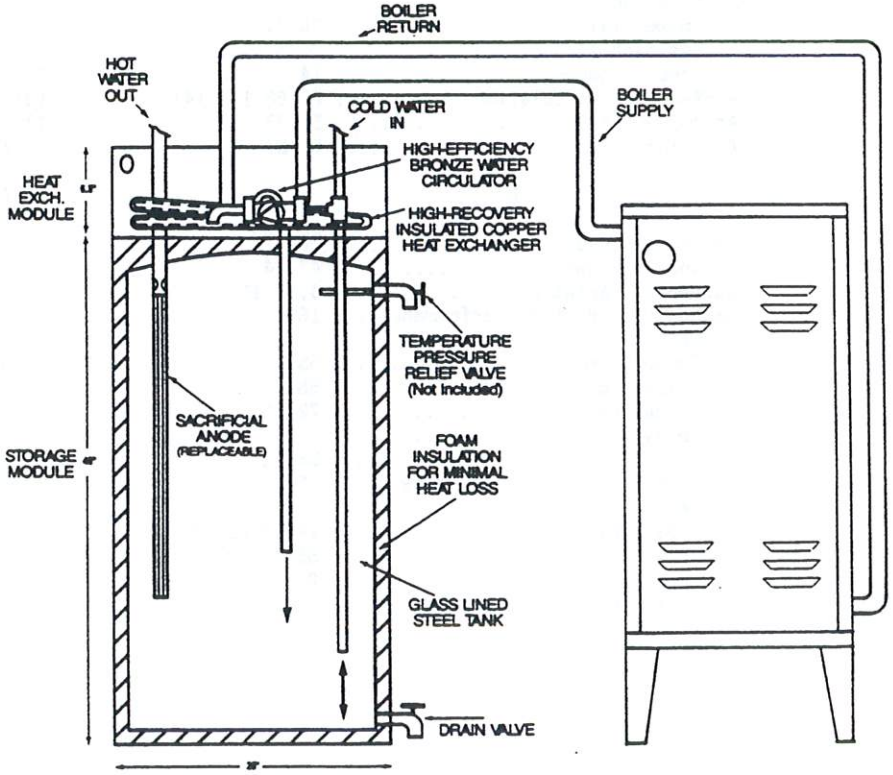
GLOWCORE WATER HEATER PERFORMANCE
FIRST HOUR DRAW BTUH INPUT

Tank Model No.	60,000 BTUH	80,000 BTUH	90,000 BTUH
WST-40			
140°F (90° Rise)	103	128	151
115°F (65° Rise)	136	169	199

OPERATION

Cold water is drawn from bottom of tank by circulator pump through annulus of heat exchanger. Water is heated by contact with counterflow water circulated in inner turbulated tube from heat source (boiler). Heated water is returned to tank middle from exchanger by dip tube.

As hot water is drawn from tank, cold water is directed to tank bottom and hot water drawn off top of tank through combination hot water outlet/anode rod. Some of the cold water flows through pump into exchanger to be heated by boiler water.



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